

NOAA Fisheries



Watershed Education

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Projects for Classes 6th – 12th



(A guide for monitoring a Stream, River or Watershed)
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(A guide for monitoring a Stream, River or Watershed)

This education package was developed for teachers and organizations to help teach and involve students and community members in watershed habitat, enhancement and monitoring. It is our vision that this package will be used as an educational tool and as a guide for groups to use when monitoring their local watershed. If you are interested in starting a watershed monitoring program, and would like assistance and or guidance in combination with this package, please feel free to contact NOAA Fisheries at 207.866.7322

Within this package you will find four sections.

Section 1

Section one consists of science projects that are an outline for a classroom environment. Each project lists the objectives, goals, time constraints, age group, tools needed and procedures. You will also find sections within each of the projects that detail preparation, discussion topics and questions to be use in class or subsequent tests. Some of the projects are further subdivided for specific age groups or class levels. If you have any question about conducting these projects with your class or organization, please feel free to contact NOAA Fisheries at 207.866.7322.

Section 2

Section two is a multipurpose section. This section of the NOAA Fisheries Watershed Education package is designed as forms, guides, surveys, instructions and tools to be used along with the projects outlined in section one of the package. Additionally, section two is designed as a monitoring program for schools, organizations and clubs to use when implementing an ongoing Watershed Monitoring/Research/Assessment (MRA) Program. If you have any question about using this section in combination with the projects in section one, or starting a Watershed *MRA Program*, please feel free to contact NOAA Fisheries at 207.866.7322.

(There are numerous positive education aspects in starting a Watershed *MRA Program*. A Watershed MRA Program will provide a way for members of your group to observe changes to a watershed over time. It can also lead to group projects towards improving your watershed, which can be conceptualized through a Watershed MRA Program.)

Section 3

Section three consists of vocabulary terms that should be used and learned when implementing the projects in sections one and two.

Section 4

References and contact information

Important!

- Before starting any project that involves chemicals, contact your local EPA office for information on the handling, disposal and guidelines that may restrict use. Also, students should have written permission from a parent or guardian to work with chemicals related to these projects.
- Before entering property owned by a private landowner, you must get written permission from that landowner to enter the property. If you are not sure who holds the title to the land, contact your local city or town officials for guidance. Within one watershed, there may be multiple landowners.
- During the process of conducting these projects or Watershed MRA Program, if your findings should produce interesting results, you can not explain your findings or need further explanation behind your findings, please feel free to contact NOAA Fisheries at 207.866.7322 or any of your local federal and/or state agencies.
- During the process of conducting these projects, if you become privy to questionable activities or discover alarming results after completing a test, please contact NOAA Fisheries at 207.866.7322 or any of your local federal and/or state agencies.

If you have any questions, concerns or want to discuss this package, or if you would like to schedule a speaker for your class, organization or group,

please feel free to contact NOAA Fisheries at 207.866.7322. You can also send a fax to us at 207.866.7432. Your local NOAA Fisheries office is located at 17 Godfrey Drive, Maine 04473. Our mailing address is 17 Godfrey Drive – Suite 1, Maine 04473.

How big is your WATERSHED?

Objective: Students will learn about, identify, and describe the watershed in which they live.

Location: Indoors

Time Frame: one to two class sessions

Subjects: All science classes

Grades: 6th - 12th

Background:

Watershed is the land area from which water drains to a particular water body.

Much like the branches of a tree, a network of stream branches are created as streams increase in flow and join with other streams. A watershed is all the land area around a divide and draining or contributing runoff to a particular body of water. It is a catch basin that guides all the precipitation and runoff into a specific river system. If one site on a watershed is affected, it will eventually affect other sites downstream and possibly upstream. A topographic map can be used to determine the contours of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution. To effectively use topographic maps, it is necessary to understand the information depicted. Topographic maps show the shape of the earth's surface using contour lines. Contours are imaginary lines that trace the land's surface at a particular elevation. Elevation is important in analyzing water flow patterns. Because water flows downhill and perpendicular to contours, a watershed can be determined from a topographical map. Intervals between contour lines are indicated on the map scale. A typical interval is 20 feet or 20 meters. Concentric circles, ovals, or ellipses indicate a knob or hill. By marking the hilltops and ridges, it's possible to create a good outline of the complete watershed.

Materials:

- Copies of a topographical map (scale 1:100,000) of the river watershed nearest the school. There needs to be a map for every group in the class.
- A large map of Maine (scale 1:24,000) showing the rivers and tributaries
- Transparency pens
- Acetate sheet and tape (plastic) - only needed if the maps are not laminated.

Preparation:

Before giving out the maps, have the Maine and topographical maps laminated so they can be used again. Be able to map out a watershed before helping the students.

Procedures:

Part one: Mapping the Watershed (Grades 6th - 12)

Discuss the following terms: watersheds, contour lines, elevation, runoff and non-point source pollution.

1. Divide the class into groups of 3 or 4. Give each group a Maine map showing the rivers and tributaries.
2. Have students find their own town or community on the maps.
3. Have students locate the main river closest to the school on the Maine map (scale 1:24,000) and trace over it with a marker or crayon.
4. Have the students locate the rivers or streams that join to form the main river and trace over them with a different color marker or crayon.
5. Give each group a topographical map. If the maps are not laminated, give each group an acetate sheet to tape to the map.
6. Have the students outline the watershed next to the school. The students should first locate the high points (hilltops) in the areas then draw the watershed following the contours.
8. Ask students to tell the direction the water is flowing and how they know. *Make sure to mark any lakes that are a result of a dam. If a dam is present, discuss the advantages and disadvantages.
9. Have students determine where the river nearest to you goes. Rivers in Maine flow to the Atlantic Ocean.

Part two: (Grades 9th - 12th) - Estimating the size of the Watershed

Materials:

1. After marking off the watershed boundaries from part one of this project, use the scale of the map and longitude and latitude marks to calculate the size of your watershed then convert to acres. (Contact the local Soil Conservation service for watershed acreage.)

2. Optional: Calculate the amount of rain that falls on the watershed by finding out the average rainfall and multiplying the value by the watershed area. It may be more appropriate if the amount of rain is converted to gallons. (Contact the local Soil Conservation Service for rainfall data.)

Discussion:

1. What is a watershed?
2. What is runoff and where does it come from?
2. Knowing the size of the watershed, how do you think the land uses in the watershed affects water quality?
3. Discuss the different land uses that exist in the watershed the students mapped out. (Examples may include farms, cropland, forests, parking lots, etc.)
4. Propose solutions to any existing problems in the watershed.

Questions:

1. What is runoff? What land uses may influence the quality of runoff? (roads, parking lots, farms and lawns)
2. How might this affect the water in the watershed's streams? (fertilizers, pesticides, silt, and other pollutants could run into the streams)
3. How is the volume and rate of runoff affected by the land use in the watershed? (More solid surface in watershed increases both.)
4. Will the conditions of the runoff in your watershed affect others downstream?
5. Where does all of the water eventually go?

Levels of Water Fall in your WATERSHED

Objective: The students will calculate the volume of water that falls onto an area of the school parking lot. Older students will compare this volume to common water-consuming activities.

Location: Indoors/Outdoors

Time Frame: divided into two class periods

Subjects: All sciences and math

Grades: 6th – 12

Background:

Contaminants get in our water source from a range of sources. Runoff from paved surfaces is probably going to contain pollutants, since none of the water or pollutants can be absorbed through the pavement. Storm water runoff from more urban areas may have sediment, debris, oil, gasoline, and heavy metals (non-point source pollution). Development may negatively affect stream health by escalating the volume of surface runoff and decrease runoff times. When it rains in areas with solid surface (parking lots, roofs, roads), water runs off at a higher speed because it is not absorbed into the ground. Possible pollutants are carried quickly from the land to the receiving water. This sometimes causes a phenomenon to occur called “shock loading”, a depletion of O_2 , which can result in fish kills or algae depending upon the type of pollutants in the runoff. Suspended materials in the runoff can also absorb and store heat, which increases the water temperature. Changes in water temperature can also harm aquatic life. Areas with lots of vegetation absorb rainwater, slow runoff and filter pollutants.

Materials:

Yardstick -Tape measure	Writing materials	Protractors
Graph paper	Calculators	Rulers
Local rainfall data	Long piece of twine (meter and foot intervals)	

Preparation:

Call the local weather center (or check out the National Oceanic and Atmospheric Administrations web page) or Soil Conservation Service in the county to find out the average annual rainfall for your area.

Procedures:

Explain to the students that they are going to calculate the volume of runoff from the school’s parking lot. This volume flows to the nearest stream.

Part one: (Grades 6th - 12th) - Calculate the area of the school parking lot and volume of runoff.

1. Divide the class into teams of 3-5 students.
2. Draw a sketch of the parking lot on the board. Have each team select an area they wish to measure. If the lot has multiple sections, give each group a certain area to measure. Note: Make sure the students use the same measurements (feet or meters).
3. Have the students go outside and take needed measurements. Transfer measurements and any landmarks to sketch on board.
4. Have students draft a sketch of the parking lot with all measurements on a regular piece of paper (**Grades 6th - 8th**) and/or to scale on graph paper (**Grades 9th - 12th**).
5. Have each team determine the direction of runoff and distance to nearest stream. Note: A map can be used to estimate a distance to the stream, if the stream is not next to the parking lot.
6. Have the students estimate the area of the parking lot. Have the students to divide up the lot into shapes, and then calculate the parking lot area. For example:

Square: $\text{Area} = \text{Length} \times \text{Width}$

Triangle: $\text{Area} = \frac{1}{2} \text{Base} \times \text{Height}$

The values should be in the units the students measured on the parking lot.

Add together all the individual shapes' areas to find the total area of the parking lot.

7. Determine the volume of rain falling on the parking lot annually. Multiply the average annual rainfall (convert to feet or meters) by the area of the parking lot (square feet or meters). Volume should be recorded in cubic feet (ft^3) or cubic meters (m^3).

Part two: (Grades 9th - 12th) - Comparisons of runoff volume to everyday water usage.

The following conversions are useful:

$$\begin{aligned}1 \text{ m}^3 &= 1000 \text{ liters} \\1 \text{ ft}^3 &= 7.2827 \text{ gallons} \\5 \text{ minute shower} &= 25 \text{ gallons or 95 liters} \\ \text{Density of water} &= 1 \text{ gallon} = 8.34 \text{ lbs.} \\1 \text{ liter} &= 1 \text{ kg.}\end{aligned}$$

1. Have students calculate the following:

Average annual rainfall:	_____ inches
Convert rainfall from inches to feet	_____ ft
	(X 1ft/12in.)
Surface Area of Parking Lot	_____ ft ²
Volume of runoff	_____ ft ³
Convert volume of runoff to gallons	_____ gallons of
runoff	
Determine how many 5 min. showers	_____ showers
can be taken with the amount of	
runoff	
If you took a shower every day, how	_____ years
long would it take to shower this	
many times?	
Determine the weight of runoff in lbs.	_____ lbs.

2. Compare the student's estimates to see the variations in values. Make sure all students understand how final answers were derived.

Questions:

1. Where does the runoff from the parking lot go?
2. What route does the runoff take? (Storm drain, drainage ditch, stream, culvert) Is the area from the parking lot to the nearest stream vegetated or paved? If both, estimate percentage of each.

Extension:

1. Predict how much erosion will occur at your school with a 30-minute rain. The following values can be obtained from the Soil Conservation Service in your county.

To calculate:

$$E = R \times K \times LS \times C \times P$$

E = Soil lost by erosion (tons/acre/yr) **R** = Rainfall factor
K = Soil erodiability factor (tons/acre) (based on the soil type)
LS = Topographic factor (based on slope) **C** = Cover and vegetation type

2. Place a rain gauge next to the school. During the next rain, record the rainfall duration and amount. Calculate the amount of rain in 30 minutes. Using the erosion calculation from above, determine the amount of erosion occurring as a result of the latest rainfall.

NONPOINT Source Pollution

Objective: Students will evaluate the effects of different land uses on wetland habitats and discuss lifestyle changes needed to minimize non-point source pollution.

Location: Indoors

Time Frame: One class period

Subjects: Science, Social Studies

Level: 6th - 8th grade

Background:

Human use of land influence wildlife habitat, positively or negatively. Land use is a reflection of human priorities and lifestyles. Sometimes people see undeveloped areas of the natural environment as little more than raw material for human use. Others believe that the natural environment is to be preserved without regard for human needs. Still others yearn for a balance between economic growth and a healthy and vigorous natural environment. At the core of land use issues is the concept of growth. Growth in natural systems has inherent limits. Continued survival for plants and animals is determined by food, water, shelter and space availability. Often, humans do not realize the impacts of their activities on the surrounding environment. Non-point source pollution is one negative impact humans may have on their local environment. Non-point source pollution harms streams.

Materials: Each group will need:

Scissors Masking tape Paste or glue Paper

One set of land use cutouts Large piece of paper to fasten the cutouts.

Preparation:

Prepare copies of the Pond and Cutout sheets ahead of time, which follows this project.

Procedures:

1. Tell the students they will be responsible for arranging the pattern of land use around the pond in such a way as to do the best they can to preserve the health of this beautiful area.
2. Divide the class into groups of three to five and give out the land use materials. Have the students cut out the land use pieces. Tell them **all** the land use pieces must be used on the pond area. The park and farmland may be cut into smaller pieces, but each piece must be used. Parts may touch, but not overlap. It is important to inform the students that the "bleach factory" must have access to the water for production and the "farm feed lot" is an area of little grass where cows are overcrowded and fed grain. Additional highways can be added. Note: Make sure they indicate which direction the water flows.
3. Have the students arrange the parts on the paper. Once all the groups have agreed on the land use location, have the groups tape the pieces to the paper.
4. Begin a discussion with the possible pros and cons of each land use. The following are a few examples:

PROS CONS

Farm: *produce food *use pesticides that may run off into the water
*economic value *soil erosion *provide jobs
*use chemical fertilizers that may damage water supplies

Businesses: *produce employment *produce wastes and sewage
*provide commerce *contaminate water (detergents, etc.)
*economic stability *use chemical fertilizers

Homes: *provides a sense of place *generate wastes and sewage
*provides a community *use water
*provides shelter *loss of wildlife habitat

5. Have the groups reexamine the pond. Without changing the land use pieces, have each group decide if the pond best supports the :

- | | |
|-------------------|-----------------------|
| a. Residents | b. Farmers |
| c. Business | d. Gas station owners |
| e. Parks | f. Highway |
| g. Bleach factory | h. Wildlife |

6. Invite each group to volunteer to display and describe their “ponds”. Look for the consequences of their proposed land use plan. Be firm about the issues, but fair about this plan. Additional points should include the need for an economic base for the town. Also, farmlands provide habitat for some wildlife, but if the wetland has to be drained for the farmland a habitat will have been destroyed. Make sure to point out the advantages to every plan. In addition, ask for any suggestions.
7. Water drains downstream, so all the wastes that go into the pond will affect the waters downstream. When all the students have finished proposing their plans, have each group tape their ponds to the board with the drainage from one group’s plan to another.
8. When each town plans its water use without considering downstream impacts, what happens? Have the students tell the possible consequences and possible solutions to the problem. For example, where will the water be treated? Where will the water go?
9. Ask the students to create a list of things they can do to begin to reduce the potentially damaging effects of their own lifestyles on the “downstream” habitats and protect water quality.

Questions:

1. What are pollutants? Give two examples from the exercise.
2. What affects does industry have on downstream water supplies?
3. What affects does agriculture have on the water supply?
4. List possible solutions to the problems associated with growth.
5. Can you name people or organizations in your area that protect streams and rivers? What do they do?

Extension:

1. Trace a stream or river system that passes through your community from its source to the sea. Look at land use adjacent to the stream or river. How does that land use affect water quality?
2. Find out about organizations that work to protect streams. Some examples are NOAA Fisheries, US Fish and Wild Life Service, the Atlantic Salmon Commission, Maine, Department of Environmental Protection.

3. Find out the quality of the local stream near the school.





Watershed **BUGS!**

Objective: Students will learn how to evaluate the quality of a stream based on the diversity of aquatic insects found.

Location: Outdoors

Subjects: Math, Science

Time Frame: One class period

Grade: 6th - 12th

Background:

Biological observation involves identifying and counting macroinvertebrates. The reason for biological observation (or monitoring) is to evaluate both the water quality and habitat of a stream. The abundance and variety of macroinvertebrates found is a sign of stream quality. Macroinvertebrates are aquatic insects, crayfish and snails that live in a variety of watershed habitats and are used as indicators of stream quality. Macroinvertebrates are present during all kinds of stream environments -- from drought to floods. These insects and crustaceans are impacted by all the stresses that occur in a stream environment, both man-made and naturally occurring. Follow steps one through three to complete a biological sample of your stream. **Note: It is important to know the potential contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.**

Materials: Optional:

- Kick screen or D-frame net preservation jars or baby food jars
- Sorting pans or white plastic tub rubbing alcohol, for preservation
- Tweezers or forceps bucket with screen bottom
- Pencils and clipboard
- Hand lens
- Rubber waders or old tennis shoes
- Rubber gloves (dishwashing gloves)

Procedures:

1. Find a sampling location in your stream. Macroinvertebrates can be found in many kinds of habitats--places like riffles (where shallow water

flows quickly over rocks), packs of leaves, roots hanging into the water, old wood or logs, or the streambed. **If present, riffle areas will have the most macroinvertebrates. If you have a stream with riffles, follow step 2a. If your stream has a muddy or sandy bottom (and no riffles), you will sample using the method in step 2b.** Sample the same stretch of stream each time, to ensure consistency (for example 50 yard stretch). Sample every three months, approximately once each season (spring, summer, fall and winter).

For streams with riffles:

2a. In this "rocky bottom" method, you will sample two different habitat riffles and leaf packs. First, identify three riffle areas. Collect macroinvertebrates in all three riffles with a kick seine, sampling a 2 x 2 feet area (the kick seines are usually 3 x 3 feet). Look for an area where the water is 3 to 12 inches deep. Place the kick seine downstream and firmly wedge the seine into the streambed. Gently rub any loose debris off rocks and sticks so that you catch everything in the seine. When you have "washed off" all the rocks in a 2 x 2 feet area kick the streambed with your feet. Push rocks around, shuffle your feet so that you really kick up the streambed. Now gently lift the seine, being careful not to loose any of the macroinvertebrates you have caught. Take the seine to an area where you can look it over or wash the contents into a bucket. Now look for decayed (old, dead) packs of leaves next to rocks or logs or on the streambed. Add 4 handfuls of decayed leaves to your sample. The total area of stream you will sample is 16 square feet.

For muddy bottom streams:

2b. In this method, you will sample three different habitats, using a D-frame (or dip) net. The habitats are: vegetated margins, wood debris with organic matter, and sand/rock/gravel streambed (or substrate). In this method you will scoop the stream a total of 14 times or 14 square feet. Each scoop involves a quick forward motion of one foot. To maintain consistency, collect the following numbers of scoops from each habitat each time you sample:

- 7 scoops from vegetated margins
- 4 scoops from woody debris with organic matter
- 3 scoops from sand/rock/gravel or coarsest area of the stream bed

As you collect your scoops, place the contents of the net into a bucket.

Separate the samples collected from the rocky streambed and vegetated margin or woody debris samples. Keep water in the bucket to keep the organisms alive. Note descriptions below of each muddy bottom habitat and collection tips:

Vegetated margins

This habitat is the area along the bank and the edge of the water body consisting of overhanging bank vegetation, plants living along the shoreline, and submerged root mats. Vegetated margins may be home to a diverse assemblage of dragonflies, damselflies, and other organisms. Move the dip-net quickly in a bottom-to-surface motion, jabbing at the bank to loosen organisms. Each scoop of the net should cover one foot of submerged (under water) area.

Woody debris with organic matter

Woody debris consists of dead or living trees, roots, limbs, sticks, leaf packs, cypress knees and other submerged organic matter. It is a very important habitat in slow moving streams and rivers. The wood helps trap organic particles that serve as a food source for the organisms and provides shelter from predators, such as fish. To collect woody debris, approach the area from downstream and hold the net under the section of wood you wish to sample, such as a submerged log. Rub the surface of the log for a total surface area of one square foot. It is also good to dislodge some of the bark as organisms may be hiding underneath. You can also collect sticks, leaf litter, and rub roots attached to submerged logs. Be sure to thoroughly examine any small sticks you collect with your net before discarding them.

Sand/rock/gravel streambed

In slow moving streams, the stream bottom is generally composed of only sand or mud because the velocity of the water is not fast enough to transport large rocks. Sample the coarsest area of the streambed--gravel or sand may be all you can find. Sometimes, you may find a gravel bar located at a bend in the river. The streambed can be sampled by moving the net forward (upstream) with a jabbing motion to dislodge the first few inches of gravel, sand, or rocks. You may want to gently wash the gravel in your screen bottom bucket and then discard gravel in the water. If you have large rocks (greater than two inches diameter) you should also kick the bottom upstream of the net to dislodge any borrowing organisms. Remember to disturb only one foot upstream of the net for each scoop. Each time you sample you should sweep the mesh bottom of the D-Frame net back and forth through the water (not allowing water to run over the top of the net) to rinse fine silt from the net. This will avoid a large amount of sediment and silt from collecting in the pan, which will cloud your sample.

2. Place macroinvertebrates in a white sorting pan or plastic sheet. Separate creatures that look similar into groups. Use the SOS identification guide to record the types and numbers of each kind of insect. As you sort through your collection, remember that each stream will have different types and numbers of macroinvertebrates. Use the table below to interpret your results.

If you find:	You may have:
Variety of macroinvertebrates, lots of each kind	Healthy stream
Little variety, with many of each kind	Water enriched with organic matter
A variety of macroinvertebrates, but a few of each kind, or No macroinvertebrates but the stream appears clean	Toxic pollution
Few macroinvertebrates and the streambed is from covered with sediment	Poor habitat sedimentation

Questions:

1. If you find low diversity of macroinvertebrates in a stream and water quality appears good, what may be influencing your stream? Hint-Is there a lot of sediment in the stream? Where do macroinvertebrates live?
2. If you sampled your stream in the winter and then found a lower diversity index in the summer, does that mean your stream has been negatively impacted? (Not necessarily, there are seasonal variations to the macroinvertebrate populations).

Extension:

1. Enlarge pictures of aquatic insects, laminate and put on poster board. Enlarge names of insects and have students match.
2. Start a regular monitoring program of a local stream. Sample quarterly.
3. Sample different streams and compare results. Be sure and look at the stream habitat AND water quality as influences on your results.

Chemical monitoring of a Watershed

Objectives: Students will gain information regarding the conditions of streams by performing chemical water quality tests and interpreting the data. Dissolved oxygen, temperature and pH will be tested in this exercise.

Location: Indoors/Outdoors

Time Frame: Two class periods

Subjects: Biology, Chemistry, Ecology

Grades: 6th – 12th

Background:

Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water-including temperature, dissolved oxygen, pH, water clarity, phosphorus, nitrogen, chlorine, and alkalinity. The basic set of tests includes temperature, pH, settleable solids, and dissolved oxygen. Advanced tests include alkalinity, phosphate and nitrate. These tests allow volunteers to take the “life signs” of their stream. In this exercise, two water samples will be compared. The first will be run inside on tap water and simple solutions, and the second will be a free flowing stream. A regular sampling program can be started, but because water conditions can vary weekly, daily or even hourly, frequent and regular sampling should be conducted (weekly or monthly).

Water temperature is important in determining which species may or may not be present in a stream system. Temperature will affect feeding, reproduction, and the metabolism of aquatic animals. Not only do different species have different requirements, but the optimum temperature may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adults. pH tests indicate the amount of hydrogen ions in the water. A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation removes carbon dioxide (CO₂) from the water during photosynthesis, increasing the pH levels.

Dissolved oxygen (DO) is critical to many forms of aquatic life. DO is measured in parts per million or ppm. One ppm is equal to one milligram of oxygen dissolved per one liter of water. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6 ppm are usually required for growth and activity. Colder water can hold more dissolved oxygen, so the highest DO levels will be found during the winter. Streams that have a high velocity and flow over rocky areas (mountain streams) likewise will have higher DO

levels because the water mixes with the air more frequently. Note: Because the quality of the stream may not be known, it is best to take precautions with students in the water. Gloves and wading boots in the stream are a must.

Note: Many of these lesson plans require a class to collect samples from nearby streams. It is vital to know the condition of the stream before sampling. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazardous to you and your students. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary or when stream conditions are unknown. In case of serious water quality problems, notify local or state authorities.

Materials:

- Dissolved oxygen test kit (Chemetrics, LaMotte or Hach)*
- pH paper or test kit (fish tank test kit, Chemetrics, LaMotte or Hach)*
- Thermometer*
- Rubber gloves
- Safety glasses
- Container to bring back waste chemicals (old milk jug)
- Bucket with rope (if sampling off a bridge or deep water)
- Pencil
- First Aid Kit
- Lemon juice
- Ammonia or Baking Soda
- Plastic cups
- Certified thermometer, LaMotte or Hach kits used in collecting quality assured data .

Procedures:

Part one:

1. Preparing the students to perform these tests on a stream requires the students spend time inside practicing with the kits.
2. Set out the lemon juice, ammonia or baking soda, an aerated water sample(aerate with air hose), and a water sample that is not aerated. Add approximately ½ cup of lemon juice or ammonia to a half gallon of water.
3. Set out thermometers, test kits and water samples.
4. Divide the class into groups and have one member of each group collect a small amount of each sample in a cup. Note: the oxygen level in the aerated sample will quickly change as oxygen diffuses back into the atmosphere.

5. Have each group conduct either the dissolved oxygen test or take the temperature and determine the pH of the samples. If time permits, have the groups switch tests so all students have run all tests.
6. Have students record results on a blank piece of paper. Compare results.

Discussion:

1. What values did you obtain for each sample? Why is the oxygen level higher in the sample that was aerated? Why does the lemon juice sample have a lower pH than the tap water? Why does the ammonia sample have a higher pH than the tap water?
2. Calculate the percentage difference between answers. Duplicate tests results should be within 15 percent.

$$\text{Percent difference} = [(1\text{st duplicate} - 2\text{nd duplicate}) / \text{average of duplicates}] \times 100$$
3. What values for DO, temperature and pH do you think will be found in a fresh water stream? Why?
4. Why are these parameters important to understanding the health of a stream?

Part Two:

1. Locate a nearby stream, pond or drainage ditch. Look on county or topographical maps to find a waterway or ask local water authorities or extension officers.
2. Review safety precautions at site. Make sure students wear safety glasses and gloves. Know location of nearest phone. Bring first aid kit.
3. Divide the class into groups. Rinse glass tubes or containers twice with stream water before running each test. Collect water samples from midstream and mid-depth. Measure the air and water temperature in the shade, avoid direct sunlight.
4. Have each group measure DO, temperature and pH.
5. Record data on a data sheet.
6. Compare results at site or back in classroom.

Discussion:

1. What values did you obtain for each sample? Why is the oxygen level higher or lower than the classroom samples? Temperature? pH?
2. Calculate the percentage difference between answers. Duplicate tests results should be within 15 percent.
3. What values would you expect at a different time of day? A different time of year?

Questions:

1. What does pH tell you about a stream? What is the optimum pH?

2. What is dissolved oxygen? How does it get into the water? What are the optimum ranges.
3. Why is temperature an important parameter to measure?

Grades 9th-12th

1. What do phosphates and nitrates measure in a stream? Is a high amount of phosphate good for a stream?

Extension:

1. Start a regular chemical monitoring program. Test at least once a month at the same location and time of day. Keep detailed records of the chemical results and graph changes throughout the year.
2. Visit a different stream or river site once a month. Compare results between sites. How do the different watersheds compare and affect water quality? Are there any point or non-point discharges?

BIOLOGICAL Fertilizer Runoff

Objective: Students will identify sources of fertilizer runoff and describe the effects fertilizer has on algal growth by performing an experiment with different water sources.

Location: Indoors

Time Frame: one class periods

Subjects: All sciences, Math and possibly Language Arts

Grades: 6th - 8th

Background:

Excess nutrients are one of the problems facing streams. Nutrients, mostly nitrogen and phosphorus, act as a fertilizer causing an increase in the growth of algae and other aquatic plants. An abundance of nutrients can cause algal blooms, which increase oxygen demand and can limit oxygen available to fish and aquatic breathing organisms. It is important to remember nutrients are important to streams, but when the nutrient load is in excess, it is harmful to the organisms living in the stream. Nutrients naturally occur in streams from leaf litter and plants. The proper amount of nutrients produces abundant plant life. However, domestic sewage, industrial wastes, chemical fertilizers from lawns and fields can reach the stream and build up. Long-term nutrient enrichment may cause a lake to be choked by vegetation, covered with scum and have a foul odor. In addition, a heavy plant bloom can reduce the oxygen and result in a fish kill.

Materials:

- Clear plastic containers, 4/group (ie. 2 liter soda containers)
- Measuring spoons
- Water samples from stream, lake or pond
- Plant fertilizer
- Tap water
- Dissolved oxygen kit (optional)
- Camera and Film (optional)
- Photographs of water bodies with algal problems and eutrophication (optional)

Preparation:

Fill several buckets or other containers with tap water and let them sit for a day or so to allow any chlorine to dissipate. Prepare fertilizer according to the package directions and double its strength. For example, if the

directions call for one teaspoon per quart add two teaspoons of fertilizer to one quart of the water sample.

Procedures:

1. Explain to the students that water pollution is (1) any human-caused contamination of water that lessens its value to human and nature; and (2) phosphorus entering lakes in runoff from fertilized area can cause heavy algal blooms and excessive weed growth in lakes.
2. Make a list of all potential sources of nutrients, which might wash into a water body after a heavy rain. The list should include agriculture, forests, plant nurseries, golf courses, home or business landscapes, and home gardens. Remember the leaf litter in the stream is also a source of nutrients.
3. The students will be observing the effects of fertilizer runoff on a water body. The plant fertilizer will represent the fertilizer being washed into streams, rivers, and lakes after a heavy rain.
4. EXPERIMENT: Have the students bring water samples to class taken from a stream, lake, pond, aquarium, or puddle and place on a table with the bucket of tap water. Divide the class into groups of two or three. Have each group get four jars.

Label the jars:

- #1 Tap Water (Control)
- #2 Tap water + fertilizer
- #3 Aquarium/pond/lake
- #4 Aquarium/pond/lake + fertilizer

Have students fill each jar with the appropriate water sample. Then have them add the appropriate amount of fertilizer to jars #2 and #4 (double strength of instructions). Set all four jars in a windowsill or a place where there is good light. Be sure not to place them in a drafty or cold location because constant temperature is needed for best algal growth. **STUDENTS MUST WASH THEIR HANDS AFTER PREPARING JARS.**

5. Have each group write a **hypothesis** of what they think will happen.
6. Observe the jars every day for a week and then once a week for a month. Record any changes in the jars on a data sheet. You may want to photograph the jars. If possible, check the dissolved oxygen in the jars once a week at **THE SAME TIME OF DAY** (oxygen levels vary throughout the day and night)
7. At the end of the experiment, have each group write their result in a report. As a class, discuss the results.

Questions:

1. Which jar has the greatest algal growth? Why?
2. Which jar had the least algal growth? Why?

3. As algal growth increases, what happens to the dissolved oxygen?
4. What happens to the oxygen levels at night? Why?
5. Name land uses and activities that contribute nutrients to streams.
6. What would result if more fertilizer were used?
7. What effects do nutrients have on aquatic life?

Extension:

1. Follow the same procedures listed above, but test for changes in dissolved oxygen rather than algal blooms.
2. Collect additional water samples from different locations of a stream or pond. Test the dissolved oxygen levels in each sample. Note the land uses of surrounding the sampling area. Have the students determine that land uses affect the oxygen level of a stream.
3. Observe algae under a microscope, have students identify types of algae.

Walking YOUR Watershed

Objective: Students will understand the concept of a watershed, identify a river's watershed system, and describe the immediate watershed in which they live.

Location: Indoors

Time Frame: one class period

Subjects: Geography, Science, Social Studies

Grades: 6th - 12th

Background:

A watershed is all the land area that contributes runoff to a particular body of water. It is a catch basin that guides all the precipitation and runoff into a specific river system. Changes in a watershed affect all living and non-living things within its boundaries. For example, a mostly forested watershed that is logged will result in changes in water flow and sediment entering streams. Sedimentation in turn will reduce the diversity of macroinvertebrates found in streams. Perhaps the single most important thing to remember about watersheds is that they are single units connected to other watersheds as they are traced downstream. What affects a watershed in one place eventually affects other sites downstream. Impacts can accumulate as water proceeds downstream. A topographic map can be used to determine the contours of a watershed, identify some land use practices, and plan best management programs to prevent or reduce pollution. To effectively use topographic maps, it is necessary to understand the information depicted. During a visit to a stream, students can learn about a watershed. The land use around the area affects the quality of a stream. For example, poor agricultural practices next to a stream may add pesticides and excessive fertilizer to the stream. Urban land uses, such as parking lots and roads contribute small amounts of oil and gas to storm-water. Students should take note of the land use and the condition of the streams. Asking questions like "Is the water silty", "Is the water a green color" and "Are there signs of pollution" will help identify the quality of the stream. See appendices.

Materials:

- Copies of a topographical map (Scale 1:1,000,000) of the river watershed nearest the school. There needs to be a map for every group in the class. A large map of Maine Scale 1:500,000) showing these rivers and its tributaries would be helpful.
- Markers, crayons, or transparency pens

- Acetate sheets or laminate for maps (optional)

Preparation:

It is vital to know the potential upstream contaminants reaching the stream.

Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Procedures:

Part One:

1. Discuss the following terms: watersheds, runoff, non-point source pollution, and land uses. Have each student look at a map of major watersheds in Maine.
2. Take the students to a river or stream, survey a 1/4 mile bank, and fill out the forms to determine land use, erosion, water color, water clarity, animal life, and human impacts on the stream.
3. In the classroom, discuss the categories and overall condition of the stream. If you suspect the stream to be polluted, ask what can be done to improve the quality of the stream? What is affecting the health of the stream?

Part Two:

Laminate the local and topographical maps so they can be used again.

1. Divide the class into groups of 3 or 4. Give each group a city or county map.
2. Have students find their own town or community on the map.
3. Have students locate the river or stream closest to the school and trace over it with a marker or crayon.
4. Have the students locate the streams that join the main river and trace over them.
5. Give each group a topographical map.
6. Have students find and trace the section or tributary of the main river that flows closest to them with a transparency pen.
7. Ask students to outline the watershed. Please see appendixes.

Questions for outline:

1. What are the lands uses in your area? (urban with roads, parking lots and buildings, suburban with houses and lawns, rural with farms)

2. How might these land uses affect the water in the watershed's streams? (fertilizers, pesticides, silt and other pollutants may run into the river).
3. How is the volume of water affected by the watershed? (the size of the watershed, land uses, and vegetation will affect the amount and quality of runoff that reaches a stream.)
4. Will the conditions in your watershed affect others downstream? How?
5. Where does all of the water eventually go?

Extension:

1. Have students identify the rivers that make up the main river watershed. Students should be able to explain how the different waters of the main river watershed are interconnected. Have them draw an imaginary river system, labeling the sources and tributaries of the river, and outlining and naming the watershed.
2. Have the students collect newspaper or magazine articles that reflect the impact of water in one area of the state on others. These could be current articles or historical ones obtained from the library.

Watershed Velocity

Objective: Students will be able to compute the velocity and discharge of a stream.

Location: Outdoors

Subjects: Math, Physics, Science

Time Frame: two class periods

Grade: 6th - 12th

Background:

Knowing the velocity of a stream is important for determining the aquatic organisms that live at a stream site. Some organisms, such as trout, prefer quickly moving, highly oxygenated water. Other aquatic critters adapt well to slow moving warm waters. Velocity is an important characteristic of your stream. The velocity of a stream equals the distance the water travels per unit of time.

Volume and discharge are also important characteristics and can be easily calculated on your stream. The volume of water flowing through your stream is the area of the stream channel multiplied by stream length. The discharge is the volume per unit of time. The total discharge of a stream is important, how much water is being drained from your watershed? The discharge may vary as land use in the watershed changes and from season to season.

Note: It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Materials:

- 50-foot piece of string or 5, 10 foot sections (marked in 1-foot intervals).
- Yardstick
- Orange
- Stop watch
- Pencils and notebooks
- Copies of water flow chart.

Procedures:

Note: Do not choose a deep pool or riffle, flowing water is dangerous and students should not be above their knees in the water. Also, consider the flow of the stream if it is moving too fast do not let the students get in the water.

For grades 6th - 8th:

1. Discuss the following terms: velocity and discharge.
2. Using the string, have the students mark off a 50-foot section (length) of a stream moving downstream. Position two students every 10 feet of the measured section. One will hold the string and one will record times.
3. Designate one student to be the timer. This student will call out times as the orange floats past each 10-foot section.
4. Release the orange upstream. Begin timing. Record results. Repeat twice.
5. Calculate stream velocity as follows: $V = \text{Distance (feet)}/\text{time (second)}$

For grades 9th - 12th:

1. Discuss velocity, volume and discharge.
2. Follow steps 1 through 5 above.
3. Divide the class into groups of four. Have each group use a string to make several measurements (approx. 4) of the width of the stream within the 50-ft measured section. Record these numbers on the provided worksheet.
4. Have the students make several depth measurements of the stream using the yardstick and record the values on the data sheet.
5. At this point, each group should draw two views of the stream: a top view including widths and a cross section with depths marked on the diagram. In the classroom, each group should:
6. Plot a stream profile. The profile plots the depth of the stream versus the width of the stream.

7. Average the depth measurements to get one number for the depth.
Average the stream widths to get one number for the width.

Student Data Sheet:

Velocity

Distance traveled	Time to travel distance (sec.)	Time to travel each 10 ft. section	Velocity (10 ft./sec.)
Average Velocity			

Volume and Discharge

Width measurements:

Depth measurements:

Average -	Average -

Calculations:

Volume = width x depth x length

Discharge = volume (ft³)/time (sec.)

NONPOINT Lethal Lots and Management Plan

Objective: Students will explain how bioassay methods are used to determine toxicity. By using *daphnia*, the students will determine the toxicity of an urban runoff water sample.

Location: Indoors/Outdoors

Time Frame: 3 class periods

Subjects: Science, Ecology, Biology, and Chemistry

Grades: 9th - 12th

Background:

Daphnia are small freshwater crustaceans that are food sources for many other animals. They are very sensitive to changes in temperature and water chemistry. For this reason, they are sometimes used for detecting the presence of toxic substances in a water supply. The examination of such organisms to detect the presence and relative amounts of toxic substances in a water supply is called biomonitoring. The technique used in this activity is called bioassay. A bioassay is a method used to test the concentration of a substance by observing its effects on the growth of an organism under controlled conditions.

Toxic chemicals in a water supply can harm the plants, animals, and humans that depend on it. Toxic chemicals and other pollutants can enter a water supply from many sources such as urban and rural polluted runoff, leaking landfills, and mining areas. Toxic chemicals from a parking lot, for example, might include oil, antifreeze, brake fluid, lead, chromium, iron, and manganese. Runoff from large areas of pavement is likely to contain pollutants. Since none of the water or pollutants can be absorbed through the pavement, the water runoff is unfiltered. In this activity, the toxicity of runoff from the school parking lots will be determined.

Materials:

- 3 liters of runoff water from the school parking lot (collect after a storm)
- Clean sponge, turkey baster, or rulers and clean dust pans to collect water
- Plastic containers with lids to store sample
- 50 live *daphnia* (available from biological supply company)
- 5 gallon container or aquarium
- *Daphnia* food:
 - tropical fish food

yeast
alfalfa
distilled water

- Aerator
- Compound microscopes
- Microscope slides and cover slips
- Blender
- 1 aquarium thermometer
- Grease pencil or permanent marker
- Labels or masking tape
- 30 eyedroppers
- 50 ml. cylinder
- 5-500 ml. beakers
- 30-50 ml. beakers
- 2-cycle semi-log graph paper
- Saturation Concentration Dissolved Oxygen data sheet
- Data sheet
- *Daphnia* media:
 - 20 liters distilled water
 - NaHCO_3
 - $\text{MgSO}_4 \times \text{H}_2\text{O}$ (Epsom salt)
 - KCL
 - CaSO_4
- Water quality test kit (optional)
- *Daphnia* anatomy sheet (optional)

Group Discussion:

1. Discuss with the students the role of urban runoff as a non-point source of pollution. Explain that runoff can contain toxic chemicals and pavement runoff will not absorb into the earth allowing it to be naturally filtered. What type of toxic chemicals could be in the runoff?). Note: Explain to the students that storm water runoff is usually piped directly into local streams. The runoff does not go to a treatment plant first before entering a stream. Urban storm water may contain sediment, debris, and toxic chemicals such as herbicides, pesticides, oil, antifreeze, and heavy metals.
2. Discuss that some organisms are more sensitive to pollutants than are others. Why are these sensitive organisms good indicators of water quality? (It is easier to detect low concentrations of pollutants with sensitive organisms.)
3. Point out the disappearance of certain plants or wildlife in a water body is an indicator of changing water quality.

4. Toxic chemicals can enter a water supply from many sources such as agriculture, mining, construction sites, and landfills, farms, homes and forestry operations.

Preparation:

You may wish to have the students perform the following:

1. When *daphnia* arrive, acclimate them to the laboratory aquarium.
Have the water temperature the same in the shipping container and in the aquarium before transferring daphnia. The culture medium in 5-gallon (20-liter) container/aquarium should be **prepared as follows**:
 - Fill a clean 20-liter container to the 19-liter mark with distilled water.
 - Pour out approx. 500 ml into a separate clean beaker and completely dissolve the following chemicals in it before adding back to the 20 liter container:
 - 2.88 g NaHCO_3
 - 1.80 g $\text{MgSO}_4 \times 7\text{H}_2\text{O}$ (Epsom salt)
 - 0.45 g KCl
 - Remove another liter from the 20 liter container into another clean container, add 1.80 g CaSO_4 . Add this mixture back to the 20-liter container.
 - Aerate the mixture for two hours using an aquarium aerator.
 - Allow the mixture to reach room temperature before adding *daphnia*.
2. Have the daphnia food prepared and feed them once a day:
 - 6.3 g tropical fish food
 - 2.6 g yeast
 - 0.5 g alfalfa
 - 500 ml distilled water
 - Blend all ingredients for five minutes on low speed. Cover and let stand in refrigerator for one hour. Pour off top liquid and save in refrigerator. Dispose of the rest.
 - Feed once a day.
 - Food is good for two weeks
3. Two days before the experiment, prepare new culture media to be used in the experiment.

Procedures:

Part one:

1. Check the *daphnia* one day prior to running the experiment to ensure that the culture is healthy. If 10 percent or more of the *daphnia* die between their arrival and this time, you may wish to reorder. Because *daphnia* are sensitive, they must be protected from hair spray, perfume, smoke, bug repellent, and the room temperature should be kept as a constant 68 degrees F.
2. Have the students collect approximately 3 liters of runoff from the school parking lot after a rainstorm in a clean container with a lid and store in the refrigerator (up to 2 weeks) until time for the experiment. Collect the runoff sample by one of the following:
 - A clean sponge to absorb the water and wring into a container, or
 - A turkey-baster to siphon the water into a container, or
 - A cleaning squeegee to push the water into a dust pan and then into a container.
3. Place **10 *daphnia* containing embryos** in each of the five 500ml beakers with 300ml of culture medium and 0.5ml of food. Make sure culture media is at room temperature. Because air bubbles can become trapped under the *daphnia*, place the *daphnia* into the media without pouring the sample. Use an eyedropper and release them slowly into the media. Note: Do not use *daphnia* with ephippia or dark eggs because they will not hatch from them in time for the experiment.
4. Use the newborn *daphnia* found in the beakers the next day for the experiment. Newborns will be smaller than the parents. Newborns are used to eliminate some sampling error from the experiments because this assures all organisms used in the experiment are the same age. (If you do not have time to remove newborns, use *daphnia* in the culture, which do not have embryos or ephippia.)
5. If water quality kits are available, test the dissolved oxygen of the media. The DO should be 40 percent saturation or greater. Otherwise, the *daphnia* will be stressed and die from low DO. Try using aerators if the DO is low.

Part two:

1. Divide the students into teams of two.
2. Give each team a compound microscope and *daphnia* (on a slide) to observe.

3. Have the students distinguish between daphnia with embryos and ephippia.
4. In the laboratory, have the students prepare and label four 50ml beakers of each of the following concentrations of runoff water. Each group will be responsible for setting up the experiment and recording the results.

Concentrations	Runoff Water	Culture Media
100%	40 ml	0 ml
50%	20 ml	20 ml
25%	10 ml	30 ml
10%	4 ml	36 ml
5%	2 ml	38 ml
2.5%	1 ml	39 ml

5. Have the students label each beaker using tape or a grease pencil. Have the student write the date, temperature, and time the experiment begins. If a DO kit is available, test the dissolved oxygen.
6. When the beakers are ready, introduce five *daphnia* into each of the beakers.
 - Use an eyedropper to transfer *daphnia*
 - Record time on each beaker
 - Do not collect *daphnia* from top or bottom of beaker.

DO NOT FEED *DAPHNIA* DURING EXPERIMENT

7. Have the students count the number of dead daphnia in each beaker at the end of 24 hours and 48 hours.
8. Distribute 2-cycle semi-log paper.
9. On semi-log paper, the lower half of the paper goes between 1-10 in logarithmic steps on the y-axis and the upper half goes from 10-100 in the same fashion. Have the students plot percent mortality (on the x-axis) and percent concentration (on the y-axis). Explain that the graph will help the students determine at which concentration the parking lot runoff has an LC50. 10. Explain LC50 or lethal concentration. This is the concentration of runoff where 50 percent of the *daphnia* die. On the percent concentration scale, have students locate the point at which 50 percent mortality occurred. This point is the LC50 for the experiment

expressed as percent parking lot runoff volume. For example, if 25 percent concentration treatment results in 50 percent mortality, then report the LC50 as 25 percent. (NOTE: If the 2.5 % concentration treatment results in greater than 50% mortality, report LC50 as less than 2.5% or repeat the procedure using a dilute sample.

Questions:

1. Why were four beakers of each concentration used? (Replication)
2. What is the purpose of the control? (To make sure other factors beside the runoff didn't kill the *daphnia*)
3. Why do some *daphnia* die before others? (Some are more sensitive than others)
4. Why is an LC50 used instead of an LC100? (LC50 is more exact. It is difficult to extrapolate because 100 percent of the organisms are dead, the concentration used in the experiment killed them)
5. On the basis of your results would you consider the runoff from the school parking lot to be toxic?
6. What can you do to protect nearby streams? (Monitor regularly and filter storm water before it enters the stream.)

Extension:

1. Invite someone from NOAA Fisheries or Maine Environmental Protection Agency to visit your school parking lot and discuss what best management practices could be used on your site to prevent pollution from begin funneled directly into water bodies. After the guest speaker, have the student's design a "**best management plan**" or BMP for your school parking lots and work with school officials to get it implemented.

Stream Chemical Monitoring

Objectives: Students will gain information regarding the conditions of streams by performing chemical water quality tests and interpreting the data.

Location: Indoors/Outdoors

Time Frame: two class periods

Subjects: Biology, Chemistry, Ecology

Grade: 9th - 12th

Background:

Chemical testing allows information to be gathered about specific water quality characteristics. A variety of water quality tests can be run on fresh water including temperature, dissolved oxygen, pH, water clarity, phosphorus, nitrogen, chlorine, total dissolved solids and salinity. Each of these parameters gives you specific information about your stream's "life signs". Chemical testing should be conducted at least once a month because this type of testing measures the exact sample of water taken, which can vary weekly, daily and even hourly. Temperature is one important factor, which determines which species may be present in the system. Temperature will affect feeding, reproduction and the metabolism of aquatic animals. Not only do different species have different requirements, but optimum habitat temperature may change for each stage of life. Fish larvae and eggs usually have narrower temperature requirements than adults. pH tests indicate the amount of hydrogen ions in the water. A range of pH 6.5 to pH 8.2 is optimal for most aquatic organisms. Rapidly growing algae or submerged aquatic vegetation remove carbon dioxide (CO₂) from the water during photosynthesis, increasing the pH levels. Dissolved oxygen (DO) is critical to many forms of aquatic life for respiration. DO levels below 3 ppm are stressful to most aquatic organisms. DO levels below 2 or 1 ppm will not support fish; levels of 5 to 6ppm are usually required for growth and activity. Phosphorous and nitrogen are nutrients found naturally in small amounts in streams. Unfortunately, many suburban and rural areas contribute excessive amounts of these nutrients to streams through fertilizer and livestock runoff. Too much phosphorous or nitrogen leads to algae blooms and fish kills.

Note: It is vital to know the potential upstream contaminants reaching the stream. Animal waste, agricultural runoff (pesticides, herbicides, etc.), industrial wastes, or sewage leaks can be hazards to students and you. If you find a stream with any of the above contaminants, a class should not

collect samples in the stream or use proper precautions. Students should wear protective boots, gloves, and goggles when necessary. In case of serious contamination, notify local authorities.

Materials:

- Water quality testing kit (LaMotte or Hach) (Should contain: dissolved oxygen, pH, temperature, phosphate and nitrate)
- Imhoff Cone for settleable solids
- Chemical Survey Sheet from appendix
- Rubber gloves
- Safety glasses
- Container to bring back waste chemicals (old milk jug)
- Bucket with rope (if sampling off a bridge or deep water)
- Pencil
- First Aid Kit

Preparation:

In preparing the activity, it is important to visit the stream. Survey the stream for any dangers, a clear path to the stream, and permission to be on the land. In addition, see the note above.

Procedures:

1. Read through test kits in class. Practice tests in class with tap water if desired. Depending on your kit, directions may vary and some are difficult to follow.
2. At the stream, divide the class into groups of 4. Assign two tests per group. Make sure students are wearing safety glasses and gloves.
3. Measure the air and water temperature in the shade, avoid direct sunlight.
4. Rinse glass tubes or containers twice with stream water before running the test.
5. Collect water for the tests approximately midstream, mid-depth.
6. Perform DO, pH, phosphate, nitrate, settleable solids.
7. Once all the parameters are collected, bring the data into the lab.
8. Have each group write the values on the board.
9. Have students share their results. Next to the parameters, have the students give one reason each parameter could be high or low.

Discussion:

With the water quality values, begin a discussion about potential water problems. Ask the students what accounts for the differences between each group's values. In addition, discuss any parameters that do not fall into the optimum conditions.

Questions:

1. What does pH tell you about a stream? What is the optimum pH?
2. What is dissolved oxygen? How does it get into the water? What are the optimum ranges?
3. What do phosphates and nitrates measure in a stream? What are sources of phosphates and nitrates? Is a high amount of phosphate good for a stream?
4. Why is it important to run duplicate samples? Some groups tested for the same substance. How did the results compare? Account for any discrepancies.

Extension:

1. Visit several streams in your area and compare chemical monitoring results. Test each site at the same time of day to minimize diurnal fluctuations.

Watershed **Breathtaking**

Objectives: Students will describe the importance of dissolved oxygen (DO) to the survival of aquatic plants and animals by performing a controlled experiment with fertilizers, debris, and sediment.

Location: Indoors

Time Frame: 4 - 30 minute sessions over 2 weeks

Subject: Science, Ecology, Biology, and Chemistry

Grade: 9th - 12th

Background:

Oxygen is important to the animals living in the water as it is to those living on land. Although oxygen does not dissolve very well in water, enough does to support a wide variety of living organisms. The solubility of oxygen in water depends on water temperature. Cool water can hold more oxygen than warmer water because gases are more soluble in cooler water. The amount of dissolved oxygen (DO) may vary significantly from one place to another and during times of the day in aquatic habitats for a variety of reasons. The highest concentration of DO occurs just at sunset. After sunset, plants respire (use oxygen). The lowest concentration of DO occurs at sunrise. This is the most likely time that a DO fish kill will occur. DO is measured in parts per million (ppm). DO in aquatic environments can range from 0 to 15 ppm, but 6-10 ppm is sufficient for most aquatic animals. Non-point sources of nutrient enrichment include fertilizers, livestock wastes, leaking septic tanks, and urban runoff. Phosphate detergents may enter water bodies in surface water runoff activities such as washing the car. Excessive nutrients entering a waterway can accelerate algae growth or cause an "algal bloom." Algal blooms can produce thick surface mats, turn the water green, stain boats, and may be toxic to animals that drink the water. When algae dies, the decaying process reduces the amount of oxygen remaining for use by aquatic animals. Heavy rains can wash a variety of suspended materials into water bodies. Many other pollutants such as bacteria and harmful chemicals can also be transported on sediment. Sediment decreases light transmission through the water, thus decreasing plant photosynthesis. In addition, livestock waste is another major non-point source pollutant. Wastes can be a major source of ammonia, a by-product of decomposition of fecal matter, uric acid, and urea.

Materials:

- 10 one-quart wide-mouth jars
- 20 sample bottles
- 10 gallons of pond water
- ½ cup grass clippings
- ½ cup liquid fertilizer
- ½ cup topsoil from garden
- 10 measuring spoons
- 10 measuring cups
- 10 thermometers
- 10 turkey basters
- Masking tape
- Permanent ink pen
- Dissolved oxygen kit or meter
- Aluminum foil
- Goggles
- Gloves
- Data chart
- Optional: ½ cup manure (Make sure to wear gloves when handling animal waste)
- Grow light

Note: Some of the equipment can be shared between groups

Preparation:

Order or borrow dissolved oxygen kits or meters. The day before the experiment, obtain topsoil, manure, and fertilizer and grass clippings. (ALWAYS handle any animal waste with gloves and wash hands afterwards.) Collect the pond-water the morning of the experiment. Water can be obtained from an aquarium. Follow standard safety procedures if students collect sample.

Procedures:

1. Explain that the amount of DO present in the water depends on the following: water temperature, amount of air mixed into the water as it moves, the amount of oxygen produced during photosynthesis by aquatic plants, the amount of oxygen used by plants and animals in respiration, and the amount of oxygen used by bacteria to decompose organic wastes.
2. Divide the class into groups of two or three and give each group a clean jar.

- Using the chart included, assign one of the ten water samples to each team and have them prepare their samples as indicated.

Sample	Treatment
1 & 2	None; 3 cups pond water only
3 & 4	$\frac{1}{4}$ cup liquid household fertilizer in 3 cups water
5 & 6(Optional)	$\frac{1}{4}$ cup manure in 3 cups water (Estimate)
7 & 8	$\frac{1}{4}$ cup grass clippings or leaf litter in 3 cups water
9 & 10	$\frac{1}{4}$ cup topsoil or potting soil in 3 cup of water

- Have the students swirl their samples (including controls) to stimulate the natural mixing of a body of water. Keep the pond/aquarium water sample to re-fill the jars on day 3 and 7.
- Have the students label the jars.
- Have the students measure and record the room and water temperature and the appearance of their samples on the data chart.
- Place the uncapped jars in a sunny location near a window. A grow light can be used if a window isn't available.
- Have the students record observations on their water samples daily for a course of 10 days. (You may wish to shorten the activity to five days. If you do, only add $\frac{1}{2}$ cup of extra water on day 3 and demonstrate the DO test near the end of the 5-day period.) They are to answer the following questions on their chart:
 - Is the water cloudy?
 - Has the color changed?
 - Is there more algal growth?
 - Is a film forming on the surface?
- On days 3 and 7, have the students add $\frac{1}{2}$ cup of the extra aquarium water into the samples. Make sure the water is at room temperature.
- Using the DO meter or kit, on the tenth day measure and record the DO of their water samples. (Use a turkey baster to transfer the water into the test bottle)
- Compile all the class data on an overhead and discuss:

- DO levels in water can be reduced by non-point source pollutants.
- DO levels can be reduced when phosphates and nitrates from fertilizers are mixed with water.
- Bacteria, which decompose organic material often, actively compete with other oxygen-demanding organisms.

Evaluation:

1. Which samples had the highest DO?
2. Arrange the DO's of the samples from highest to lowest and discuss why you got these results.
3. Assuming the water was taken from a stream, what types of fish and macroinvertebrates would likely be present in each of the streams?
4. What are the most likely non-point sources of organic waste pollution in streams?

Extension:

1. Test DO upstream and downstream from a suspected non-point source of fertilizer or livestock waste. Does the DO content differ in these two areas? Why? What factors may be responsible for these differences? REMEMBER: Follow safety precautions.
2. Perform DO test as before on freshwater streams containing different sediment loads. Correlate DO with sediment loads and discuss the results with each student.

***Getting Started* Watershed**

- Identify a Stream Segment, Wetland or Lake Area to Monitor
- Determine the Official Name of Your Water body
- How To Obtain Maps and Other Information
- Determine Which Watershed You Are In
- Determining Your Lat/Long
- Sample Delineated Watershed
- Name Your Group
- Why Am I Monitoring? Setting Goals
- Determine What Equipment and Resources You Need
- Find Local Partners
- Determine What Data Will Be Collected
- Make a "Who To Call" List
- Inform a Local Official
- Public Outreach

Identifying a Stream Segment, Wetland or Lake to Monitor

Some general guidelines to follow for selection of a stream segment, wetland or lake:

Select a water body meaningful to you or your group.

Select a location that has **easy, safe, and legal** access.

Select a project that meets your monitoring goals.

Stream

Choose a stream that is meaningful to you and your group. Do you want to learn more about a stream that flows near your home or school? Many communities study an entire watershed and monitor several sites. Comparing the effect of land uses on water quality can be interesting (sample upstream and downstream of a farm, an urban area, etc.). We suggest that you choose a ½ mile segment of stream to monitor. During the watershed survey, you will locate one monitoring point that is representative of your stream segment. From this location, you will conduct the visual surveys, chemical and biological monitoring.

Wetland

Wetlands are not as common and easy to find as streams and creeks. For this reason, it is advisable to work with a local partner who may own land where a wetland is located or contact a government agency for permission to work on publicly owned land. By purchasing a USGS topographical quadrangle of the area of interest, you may learn if a wetland is present. A better estimation of wetland location will be found on a NWI map (National Wetland Inventory). These quadrangles correlate to the USGS topographic maps and are specifically made to identify and classify wetlands.

Lake

In Maine there are many small and large lakes ranging from farm ponds to large reservoirs. Do you want to monitor a small pond, a larger lake or one or more sites on a large reservoir?

Determine Official Name of Your Watershed

Many streams, wetlands and small ponds are not named on the maps. If this is the case for your water body, contact your county or city water or utilities department and ask them if they have named the water body. Some groups make up their own names, but if this does not correspond to the name used by the municipality or State, it will be hard to associate your data to the appropriate water body. If you are looking at a stream or wetland associated with a larger stream that is named, you should call the stream “a tributary to (name of bigger stream)” or “wetland adjacent to (name of water body).” For example, a small tributary running into Orono Creek would be called “unnamed tributary to Orono Creek.” Also include the location such as, “flows under Main Street in Downtown Orono”.

How To Obtain Maps And Other Information

Stream headwaters, length, tributaries, final stream destination, and watershed boundaries are best determined through maps. Of greatest value are U.S. **Geological Survey 7.5- minute topographic maps** (on a 1:24,000 scale where 1 inch = 2,000 feet). They depict landforms, major roads and political boundaries, developments, streams, tributaries, lakes, and other land features. Sporting goods stores and bookstores often carry these maps, especially for recreational areas that are likely to be hiked or camped. The maps can also be ordered through the U.S. Geological Survey (see Obtaining USGS Topographic Maps below). Small versions are available online at <http://www.topozone.com>.

Road, state, and county maps might also prove helpful in identifying some of these stream and watershed features. **Hydrologic unit maps**, also available from the U.S. Geological Survey but at a 1:100,000 scale of resolution (less detail than the 7 1/2-minute maps cited above) might also help you determine hydrologic watershed boundaries. **Atlases** and other reference materials at libraries can prove helpful in determining facts about population in the watershed. Land uses in the stream watershed might also be depicted on maps such as those discussed above. You will verify this information in the second half of the watershed survey, when you are actually in the field observing land around your water body. Information from maps is particularly useful in developing a broad statement about general land use in the watershed (e.g., land use in the hypothetical Volunteer Creek watershed is 60 percent residential, 20 percent parkland/recreational, and 20 percent light industrial). Much information about your local watershed can be obtained from the internet. **EPA Surf Your Watershed** (<http://www.epa.gov/surf3/states/MA/>) is a good place to start, however there are other sources for obtaining detailed maps, both topographical and aerial views. Check with your local government, library and the internet for your options.

Name Your Group

On the forms that follow this introduction, a few different names are requested. The first is the official name of your water body. The next name is the lead coordinator. That will be the main contact person for the group, and his or her address and phone number should be written on the form. The next name is the name of your group. This can be a fun name or the official name of your organization that is monitoring a water body. Once you have chosen a name, be consistent. This name will be used to track your data forms throughout the year.

Why Am I Monitoring? Setting Goals

Generally, a *goal* is a broad statement that encompasses the purpose of your involvement in watershed monitoring. An *objective* is a specific, measurable, action oriented activity that will help you achieve your goals. Don't get weighed down with the definition of goals and objectives. What is important here is that you have a clear picture of why you are adopting a stream, wetland or lake and what you hope to achieve from your efforts. Then you can decide which activities you will conduct. As you can imagine, the goals and objectives of each group may be very different. Below are examples of goals and activities that you may consider for your program.

Goals:

- To learn more about my local stream and watershed.
- To educate the community about water quality, watersheds and nonpoint source pollution.
- To collect baseline water quality or stream morphology data.
- To get the community involved in a hands-on effort to protect the lake.
- To form a watershed alliance.
- To work in partnership with local governments and businesses to protect our water.
- To teach aquatic biology to students.

Objectives:

- Conduct the watershed survey and map assessment.
- Speak at the neighborhood association or local church about your watershed
- Obtain \$400 sponsorship from a local business to purchase monitoring equipment.
- Conduct Visual Surveys four times a year.
- Collect data on pH, dissolved oxygen, temperature and nitrate-nitrogen once a month for three years.
- Organize two cleanups this year.
- Ask someone at the local water authority to act as your technical advisor.
- Send a letter to a local official, informing him or her of your intentions.
- Write an article in your local paper with information on "Who to Call" if someone sees a water quality problem.

- Collect data that will be useful to at least three entities (watershed organization, county water authority, local college).

Determine What Equipment and Resources You Need

Think about the equipment and resources you will need to accomplish your goals. This may include topographic maps, boots, chemical test kits, nets, garbage bags or information on how to form a watershed group.

Equipment List for Watershed Survey and Map Assessment

Watershed Forms

Topographic map
Transparency paper
Land use map
Camera
Tape measure
First aid kit
Boots
Gloves

Equipment List for Visual Stream Survey

Watershed forms

Camera
Tape measure
8 – 10 ft. measuring stick
An orange
Calculator
Twine
Line level
Rebar
Pencil
Waterproof paper
Clear jar

Equipment List for Chemical Monitoring

Eye protectors
Boots
Gloves
First aid kit
Test kits for pH, Dissolved Oxygen, Nitrate-nitrogen, Phosphate, Alkalinity
Thermometer
Imhoff cone
Waste bucket
Chemical data forms

Equipment List for Biological Monitoring

Watershed Forms
D-frame or kick seine net
Buckets
Forceps
Spoons
Pipettes
Sorting trays
Macroinvertebrate key (laminated)
Collecting jar with alcohol

Equipment List for Wetland Monitoring

Tape measure
Shovel
Soil color chart (laminated)
Local plant ID book
Wetland survey forms

Equipment List for Lake Monitoring

Secchi Disk
All equipment listed under Chemical Monitoring

Find Local Partners

Local partners can help make your project a success in many ways. They can offer technical advice, donate equipment, or facilitate access to the water body. The more partners you have, the more your efforts will be magnified throughout your community.

Examples of local partners:

- Large private landowners such as timber companies who may have wetlands on their property.
- Government agencies like the NOAA Fisheries, US Fish and Wildlife, USDA, the Extension Service or the US Geological Survey.
- Municipalities who may have an interest in working with citizen monitoring groups.
- Environmental education centers.
- Professors at colleges or universities.
- A local bank that will sponsor your group.
- A corporation interested in promoting and supporting environmental stewardship.

Watershed **Monitoring Package**

Complete the following form for each stream segment, wetland or lake you monitor. We must have a completed form on file at the state office in order to include your efforts on our web site and database.

This form is to register the monitoring of a:

STREAM
(Circle one)

WETLAND

LAKE

Name of stream / wetland / lake you are monitoring (official name)

Lead Coordinator / Contact

Complete Mailing Address

Phone Number(s)

E-mail Address

Topographic Map Quadrangle (**include copy of map**) on which your water body can be located Watershed (Latitude / Longitude, County, Today's Date).

1. Describe the location of your monitoring site (i.e. 25 yards downstream of Smallville crossing in Smallville Village).
2. What is the name of your monitoring group? (i.e. Science Club, Smallville High School , Smallville Science Club)?
3. If associated with a larger group (i.e. NOAA Fisheries) please list them here.
4. Who are your partners (partners may contribute equipment, provide skills or services, provide technical support or grant you access across their land)?
5. What are the goals you hope to accomplish with the on going community watershed monitoring program?
6. What equipment or supplies do you need to achieve your goals?
7. Where will you send the data you collect?
8. Name of the local official or agency that you have informed about your program.
9. Name the QA/QC data collectors in your group.

Watershed **Survey and Map Assessment**

Group name: _____		Investigator(s): _____
Type of water body: stream / wetland / lake _____		
Water body name: _____		County(ies): _____
Approximate size of drainage/study area: _____ acres		
Date: _____	Time: _____	Picture/photo documentation?
Yes/No _____	_____	

I. CREATE A MAP OF YOUR WATERSHED

(create or generate a map of your water shed. Mark locations and key points of interest. Provide a legend at the bottom of your map)

II. LAND USES/ACTIVITIES AND IMPERVIOUS COVER

1. Identify land uses and activities in the watershed, which have the highest potential to impact water bodies:

Check all boxes that apply, describe the location of the activity(ies) under Notes on Location & Frequency of Activities and also mark the locations on your map. If too frequently occurring to record locations, so note. If you don't know some of the information below, write DK under Notes.

Please indicate if you: ☐ surveyed only adjacent to the water body
☐ surveyed the whole watershed
 Provide notes as necessary

Land Disturbing Activities & Other Sources of Sediment	Adjacent to Water	In Watershed	Notes on location & frequency of activity
Extensive areas disturbed by land development or construction of utilities, roads & bridges	—	—	_____
Large or extensive gullies	—	—	_____
Unpaved roads near or crossing streams	—	—	_____
Croplands	—	—	_____
Pastures with cattle access to water bodies	—	—	_____
Commercial forestry activities including harvesting and site-preparation	—	—	_____
Extensive areas of streambank failure or channel enlargement	—	—	_____
Other Agricultural Activities			
Confined animal (cattle or swine) feeding operations and concentrations of animals	—	—	_____
Animal waste stabilization ponds	—	—	_____
Poultry houses	—	—	_____
Highways and Parking Areas			
Shopping centers & commercial areas	—	—	_____
Interstate and controlled access highways and interchanges	—	—	_____

Major highways and arterial streets	–	–	_____
Other extensive vehicle parking areas	–	–	_____
Mining			
Quarries with sediment basins in live flowing stream	–	–	_____
Transportation and Motor Vehicle Services	Adjacent to Water	In Watershed	Notes on location & frequency of activity
Truck cleaning services	–	–	_____
Public and private automobile repair facilities	–	–	_____
Car washes and large auto dealers	–	–	_____
Rail or container transfer yards	–	–	_____
Airports with fuel handling/aircraft repair	–	–	_____
Business & Industry, General			
Activities with exterior storage or exchange of materials.	–	–	_____
Activities with poor housekeeping practices indicated by stains leading to streams or storm drains or on-site disposal of waste materials	–	–	_____
Heavy industries such as textiles & carpet, pulp & paper, metal, and vehicle production or fabrication	–	–	_____
Dry cleaners/outside chemical storage	–	–	_____
Food & Kindred Products			
Fertilizer production plants	–	–	_____
Feed preparation plants	–	–	_____
Meat and poultry slaughtering or processing plants	–	–	_____
Construction Materials			

Wood treatment plants	-	-	_____
Concrete and asphalt batch plants	-	-	_____

Waste Recycling, Movement & Disposal	Adjacent to Water	In Watershed	Notes on location & frequency of activity
Junk and auto salvage yards	—	—	_____
Solid waste transfer stations	—	—	_____
Landfills and dumps (old & active)	—	—	_____
Recycling centers	—	—	_____
Drum cleaning sites	—	—	_____
Illicit Waste Discharges*			
Sanitary sewer leaks or failure	—	—	_____
Overflowing sanitary sewer manholes due to clogging or hydraulic overloading	—	—	_____
Bypasses at treatment plants or relief valves in hydraulically overloaded sanitary sewer lines	—	—	_____
Domestic or industrial discharges	—	—	_____
Extensive areas with aged/malfunctioning septic tanks	—	—	_____
Dry-weather flows from pipes (with detectable indications of pollution)	—	—	_____
Streamside areas of illegal dumping	—	—	_____

* If found (most likely during stream surveys), these activities should be immediately reported to the local government.

II Percent impervious surface *acre overlay, example map and acreage calculating grid.*

Coverage category for LANDUSE MAP method	impervious Quotient	times	percent of... impervious cover	percent of
Forest/open land/undeveloped land /vacant/land owned by institutions	.005	x		%
Agriculture/pasture/cropland	.005	x		%
Single family residential % (1.1 - 5 acre lot or no more than 1 dwelling per acre)	.12		x	
Single family residential % (.5 - 1 acre lot or 0 – 2 dwellings per acre)	.19		x	
Low density residential / single % family residential (.25 - .5 acre lot or 0 – 4 dwelling units per acre)	.26		x	
Low/medium density residential (.25 acre lot or smaller or 0 –8 dwelling units per acre)	.48	x		%
Medium density residential (0 –12 dwelling units per acre)	.56	x		%
High density residential (18 – 30 dwelling units per acre)	.65	x		%
Townhouse/apartment.	.48	x		%
Office/light industrial (assembly, finishing, packaging products)	.70	x		%
Heavy industrial (timber, chemical, cement, brick plants, lumber mills)	.80	x		%
Commercial (business districts, commercial strip development, shopping centers, warehouses, parking lots, office buildings)	.85	x		%
Major roads	.90	x		%
Total percent of watershed covered by impervious surfaces				%

III. WATERBODY AND WATERSHED CHARACTERISTICS

This information will be gathered from your wetland, lake or stream segment.

- 1. Note the number of hydrologic modifications on your water body:**
structures that alter water flow

None	_____	Beaver dams	_____
Dams	_____	Dredge spoils	_____
Bridges	_____	Pipes	_____
Waterfalls	_____	Other	_____

- 2. Note the approximate length of the stream that is affected by the following:** *if assessing a wetland, lake or pond, some of the following may also affect your water body.*

Stream culvert	_____ feet or _____ mile or _____ % of stream length
Stream straightening	_____ feet or _____ mile or _____ %
Concrete streambank/bottom	_____ feet or _____ mile or _____ %
Dredging/channelization	_____ feet or _____ mile or _____ %
Riprap/gabion	_____ feet or _____ mile or _____ %
Cattle crossing	_____ #
Stream crossing (for vehicles)	_____ #

3. Note extent of vegetative buffer along the banks: *at a minimum of 5 sites*, at regular intervals (every 500 ft. in a ½ mile. section) note the following*

#	Width in feet	Location (Left bank, Right bank or N, S, E, W side of wetland or lake)	Characteristics and Comments
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

4. Check the categories that best describe the general appearance of the water body:

Litter:

- ☐ No litter visible
- ☐ Small litter occasionally (i.e., cans, paper)
- ☐ Small litter common
- ☐ Large litter occasionally (i.e., tires, pallets, shopping carts)
- ☐ Large litter common

Special Problems:

- ☐ Spills of chemicals, oil, etc.
- ☐ Fish kills
- ☐ Wildlife, waterfowl kills

Erosion:

- ☐ No bank erosion or areas of erosion very rare; no artificial stabilization
- ☐ Occasional areas of bank erosion
- ☐ Areas of bank erosion common
- ☐ Artificial bank stabilization (i.e., riprap) present

5. Comments on general water body and watershed characteristics: (e.g. date and size of fish kill, increased rate of erosion evident, litter most evident after storms)

* Fish kills should be immediately reported

6. Summarize notable changes that have taken place since last year (if this is not your first year conducting the Watershed Survey).

IV. PIPE AND DRAINAGE DITCH INVENTORY

In this section, provide information on pipes and drainage ditches found on the banks or in the water body. These pipes/ditches can be abandoned or active. Note the information for each pipe or drainage ditch you observe. *Make additional copies as necessary.*

Pipe #	Location	Type	Size	Flow	Water body condition	Comments

- 1. Number each pipe/ditch** for mapping/locating purposes
- 2. Location of pipe/ditch:** note whether in water, bank, near water body or other. Describe location.
- 3. Identify type of pipe (list all that apply):** PVC, iron, concrete, galvanized; industrial outfall, sewage treatment plant outfall, storm drain, combined sewer overflow; agricultural field drainage, paddock or feedlot drainage, settlement basin/pond drainage, parking lot drainage, unknown, other
- 4. Size: measure approximate diameter of pipe:** inches or centimeters
- 5. Describe the discharge flow:** Rate of flow: none, intermittent, trickle, steady, heavy. Appearance: clear, foamy, turbid, oily sheen, color, other. Odor: none, rotten eggs/sewage, chemical, chlorine, other
- 6. Water body condition: describe the bank/water body below pipe or drainage ditch:** no problem evident, eroded, sewage litter (e.g. toilet paper), litter (e.g. bottles, cans), lots of algae, other
- 7. Comments of pipes and drainage ditches:** Use this space to explain or expand on information provided on pipes and discharges you have identified above. For example, you may want to identify particular facilities, or discuss in more detail the condition of the water body below the discharge. Use separate page if necessary.

Determining Your Latitude and Longitude

So that others can find the exact location of your monitoring site, you will need to know how to determine the latitude and longitude of your site. To locate the coordinates, you will need to work with a topographic map and have access to the web. You can find maps on the web at www.topozone.com. Scroll down to the bottom of the screen and type the official name of your water body in the area designated "Place Name." If you are working with an unnamed tributary to a larger stream, type in the name of the larger stream. Select your state (ME) on the pull-down menu, and click "Search." This should bring up a list of all sites with that name. Select your site by clicking on the link, which will take you to a topographic map of the area. Locate your exact data collection point as closely as possible and click on it, using the green arrows at the edges of the map to change the view if necessary. A small red mark should appear where you click, allowing you to keep track of your site. Now go to the top of the map and click on the 1:25,000 scale option, which will zoom in on the red mark. Adjust its position if necessary. At the bottom of the map, three coordinate format options will appear. Select the one-labeled "DD.DDDD" for decimal degrees. The latitude and longitude of your site and the name of the quadrangle will appear above the map. Print this map for your records, noting the scale, coordinates, quadrangle, and date of production, which may be obtained by clicking "Quad Info" in the upper right corner of the screen.

To obtain a hard copy of the topographic quadrangle map, contact the US Geological Survey may be reached at 1-800-USA-MAPS. Maps cost \$4 each plus shipping and handling. To order the map, you will need the name of the quadrangle, the scale of the map and the date it was printed. NOTE: Your water body may cover more than one quadrangle. While topozone.com provides lovely maps, its coordinates may not be precise. Therefore, to determine the exact latitude and longitude of your site (important for future studies!), you should now visit <http://tiger.census.gov>. Scroll down and click on "The TIGER Mapping Service." This will bring up a default map. About three quarters of the way down the page, enter the latitude and longitude you obtained from topozone.com in the designated spaces under BOTH "Place a Marker on this Map" and "Enter Precise Coordinates." Set the map width to 0.022 and the map height to 0.009, and click "Redraw map." Locate your data collection site, which should be fairly close to the marker. To the right of the map, under "Click on the image to:" select "Place Marker" and click on your site as precisely as you can. When the map reloads, scroll down to

the original "Place a Marker on this Map," which will now show the new, more accurate coordinates of your marked site. Record these coordinates for your final data sheets, and print this map for your records.

Macroinvertebrate Count Forms

To be conducted quarterly

Group name: _____		County: _____	
Site ID _____		Topo Map Quadrant: _____	
Investigators: _____			
Stream name: _____			
Date: _____		Time: _____	
Photo Documentation? yes / no			
Site/location Description: _____			
<div style="display: flex; justify-content: space-between;"> <div> <p><i>Rain in last 24 hours</i></p> <p>heavy rain steady rain heavy rain</p> <p>intermittent rain none overcast partly</p> </div> <div> <p><i>Present conditions (circle response)</i></p> <p>steady rain intermittent rain</p> <p>cloudy clear/sunny</p> </div> </div> <p>Amount of rain, if known? _____ Inches in last _____ hours/days</p>			

Use letter codes (**A**=1-9, **B**=10-99, **C**=100 or more) to record the numbers of organisms found in a total sample. Then add up the number of letters in each column and multiply by the indicated value. The following columns are divided based on the organism's sensitivity to pollution

Method used:
 _____ Muddy Bottom
 _____ Rocky Bottom

Habitat selected for sampling:
 _____ riffle
 _____ leaf pack/woody debris
 _____ streambed with silty area (very fine particles)
 _____ streambed with sand or small gravel
 _____ vegetated bank
 _____ other (specify) _____

<p>SENSITIVE</p> <p> <input type="checkbox"/> caddisfly <input type="checkbox"/> hellgrammite <input type="checkbox"/> mayfly nymphs <input type="checkbox"/> gilled snails <input type="checkbox"/> riffle beetle adult <input type="checkbox"/> stonefly nymphs <input type="checkbox"/> water penny larvae </p>	<p>SOMEWHAT-SENSITIVE</p> <p> <input type="checkbox"/> beetle larvae <input type="checkbox"/> clams <input type="checkbox"/> crane fly larvae <input type="checkbox"/> crayfish <input type="checkbox"/> damselfly nymphs <input type="checkbox"/> dragonfly nymphs <input type="checkbox"/> scuds <input type="checkbox"/> sowbugs <input type="checkbox"/> fishfly larvae <input type="checkbox"/> alderfly larvae </p>	<p>TOLERANT</p> <p> <input type="checkbox"/> aquatic worms <input type="checkbox"/> blackfly larvae <input type="checkbox"/> leeches <input type="checkbox"/> midge larvae <input type="checkbox"/> pouch snails </p>
<p># of letters times 3 = _____</p>	<p># of letters times 1 = _____</p>	<p># of letters times 2 = _____</p>
<p>Now add together the three index values = _____ total index value</p>		

The total index value will give you an indication of the water quality of your stream. Good water quality is indicated by a variety of different kinds of organisms, with no one kind making up the majority of the sample.

WATER QUALITY RATING

☐ Excellent (>22)
☐ Good (17-22)
☐ Fair (11-16)
☐ Poor (<11)

To be conducted every 3 months

Rain in last 24 hours *Present conditions (circle response)*
heavy rain steady rain heavy rain steady rain intermittent rain
intermittent rain none overcast partly cloudy clear/sunny

Amount of rain, if known? _____ Inches in last _____ hours/days

1. Stream reach: The total-distance upstream to downstream of your monitoring point from which you will be collecting your data. The stream reach is 12 times your stream width, bankfull to bankfull.

bankfull width _____ ft. x 12 = stream reach _____ ft.

2. Water flow: Present conditions:

☐ in channel ☐ flooding over banks ☐ dry / no flow / pooling

Number of pools _____ Number of riffles _____ Number runs _____

3. Flow rate: where Flow = Area X Speed X coefficient
(Turn for stream flow calculating form.)

CALCULATING STREAM FLOW

Flow = Area X Speed X Coefficient

CALCULATE AREA

Area = depth x width

It is advisable to take multiple depth and width measurements always start at the waters edge with a first measurement of zero all data should be recorded in feet, with inches replaced by increments of 10

Depth measurements	1. 0 ft	2.	3.	4.	5.	6.	7.	8.	sum
--------------------	------------	----	----	----	----	----	----	----	-----

Average depth = $\frac{\text{sum of depth measurements}}{\text{number of measurements}}$

Width measurements	1.	2.	sum
--------------------	----	----	-----

Average width = $\frac{\text{sum of width measurements}}{\text{number of measurements}}$

Area = width X depth

CALCULATE SPEED-measure the time it takes a float to travel a desired distance *it is advisable to take at least 2 measurements of current speed take measurements from the stream run*

length in feet 20 feet is recommended

Time In seconds	1.	2.	3.	4.	sum
-----------------	----	----	----	----	-----

Average time = $\frac{\text{sum of time measurements}}{\text{number of measurements}}$

Speed = $\frac{\text{length in feet}}{\text{average time in seconds}}$

CALCULATE STREAM FLOW

Flow _____ cfs = _____ Area X _____ Speed X _____ Coefficient

Flow in cubic feet per second

.9 coefficient for muddy bottom stream

.8 coefficient for rocky bottom stream

Measure Channel Cross Section:

Drawing a stream cross section allows you to observe/track changes in your stream channel shape. Forms are found on the last page of this section.

4. Tidal range: *(complete only if site is affected by tide)*

Is waterway influenced by tides? ☐ Yes ☐ No If yes, when? _____

If tidally influenced: Tide was: ☐ Rising ☐ Falling

Tide was: ☐ High ☐ Mid-range ☐ Low

5. Embeddedness: Pick the category that best describes the extent to which gravel, cobbles, and boulders on the stream bottom are embedded (sunk) in silt, or mud. *Observations should be conducted from the riffle section of your stream as opposed to run or pool areas. Only complete if applicable to your stream.*

☐ somewhat/not embedded (0 - 25%) ☐ mostly embedded (75%)
☐ halfway embedded (50%) ☐ completely embedded (100%)

Pebble count: This is an easy way to determine the percentage of silt, sand, gravel, rocks and boulders on your streambed.

6. Presence of naturally occurring organic material in stream: *(Good habitat for aquatic organisms)*

Logs or large woody debris: ☐ none ☐ occasional ☐ plentiful
Leaves, twigs, root mats, etc.: ☐ none ☐ occasional ☐ plentiful

7. Water odor: 8. Water surface:

☐ natural/none ☐ gasoline ☐ clear ☐ natural oily sheen
☐ sewage ☐ chlorine ☐ foamy ☐ other
☐ rotten egg ☐ chemical ☐ oily sheen (petroleum product)
☐ other _____

8. Water clarity: check all that apply *(determine by viewing sample water in a clear container)*

☐ turbid - suspended matter in water ☐ sediment
☐ blue/green algae ☐ other

☐ tannic - clear water that is naturally stained orange/brownish due to organic acids in water

☐ no staining / no suspended matter ☐ other (i.e. chemical discharge, dyes)

Notes: _____

9. Bank erosion:

How vegetated is the left bank, looking down stream, for the length of your reach (circle a percentage)?

Vegetated banks								Bare/eroded banks			
100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0	

What are the visual indicators you used to assess the percentage above (check all that apply)?

<input type="checkbox"/> exposed soil	<input type="checkbox"/> obvious loss of soil	<input type="checkbox"/> soil covered with vegetation
<input type="checkbox"/> steep slopes (banks are U shaped)	<input type="checkbox"/> gentle slopes	
<input type="checkbox"/> exposed roots	<input type="checkbox"/> no exposed roots	

How vegetated is the right bank, looking down stream, for the length of your reach (circle a percentage)?

Vegetated banks								Bare/eroded banks			
100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0	

What are the visual indicators you used to assess the percentage above (check all that apply)?

<input type="checkbox"/> exposed soil	<input type="checkbox"/> obvious loss of soil	<input type="checkbox"/> soil covered with vegetation
<input type="checkbox"/> steep slopes (banks are U shaped)	<input type="checkbox"/> gentle slopes	
<input type="checkbox"/> exposed roots	<input type="checkbox"/> no exposed roots	

10. Additional comments/observations:

II. VISUAL BIOLOGICAL SURVEY

1. Wildlife in or around the stream:

☐ amphibians ☐ waterfowl ☐ reptiles ☐ mammals
☐ mussels/clams/oysters ☐ crustaceans

2. Fish in the stream: (Check all that apply)

☐ no ☐ yes, but rare ☐ yes abundant
☐ small (1-2") ☐ medium (3-6") ☐ large (7" and above)

Are there barriers to fish movement?

☐ none ☐ beaver dams ☐ waterfalls > 1ft
☐ dams ☐ road barriers ☐ other :

3. Aquatic plants in the stream: (Check all that apply)

☐ none

attached plants	stream margin/edge	pools	near riffle
occasional	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
plentiful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
free-floating plants	stream margin/edge	pools	near riffle
occasional	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
plentiful	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

4. Extent of algae in the stream: Are the submerged stones, twigs, or other material in the stream coated with a layer of algae? (Check all that apply)

☐ none

brownish:	light coating	heavy coating
occasional	<input type="checkbox"/>	<input type="checkbox"/>
plentiful	<input type="checkbox"/>	<input type="checkbox"/>
greenish:	light coating	heavy coating
occasional	<input type="checkbox"/>	<input type="checkbox"/>
plentiful	<input type="checkbox"/>	<input type="checkbox"/>
other _____:	light coating	heavy coating
occasional	<input type="checkbox"/>	<input type="checkbox"/>
plentiful	<input type="checkbox"/>	<input type="checkbox"/>

Are there any filamentous (string-like) algae?

	none	occasional	plentiful
brownish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
greenish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
other :	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Are any detached "clumps" or "mats" of algae floating on the water's surface?

	none	occasional	plentiful
brownish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
greenish	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
other :	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

5. Stream shade cover: How well is the water surface shaded by vegetation?
Looking down stream:

Total shading										No shading	
100%	90%	80%	70%	60%	50%	40%	30%	20%	10%	0	
<hr/>											

6: Additional comments/observations:

III. SKETCH OF MONITORING SITE / STREAM REACH

On the back of this page, or on a separate page, note the physical features of the stream reach, such as: riffles, pools, runs, streambanks (bare or eroded), changes to stream shape (rip-rap, gabions, cemented banks), vegetation, stream flow obstructions (dams, pipes, culverts), outfalls, tributaries, landscape features, paths, bridges, and roads.

As accurately as possible, identify the location of **channel cross-section** measurements and provide **exact location of stream reach** (e.g. Cricket Creek stream reach begins 57 feet north of Cormorant Bridge.) Include comments such as changes or potential problems, e.g. spills, new construction, type of discharging pipes, etc.

Stream Channel Cross-section Measurement Data

Group name: _____ County: _____

Site ID _____ Topo Map Quadrant: _____

Investigators: _____

Stream name: _____

Date: _____ Time: _____ Photo Documentation? yes / no

Site/location Description: _____

Rain in last 24 hours *Present conditions (circle response)*

heavy rain steady rain heavy rain steady rain intermittent rain

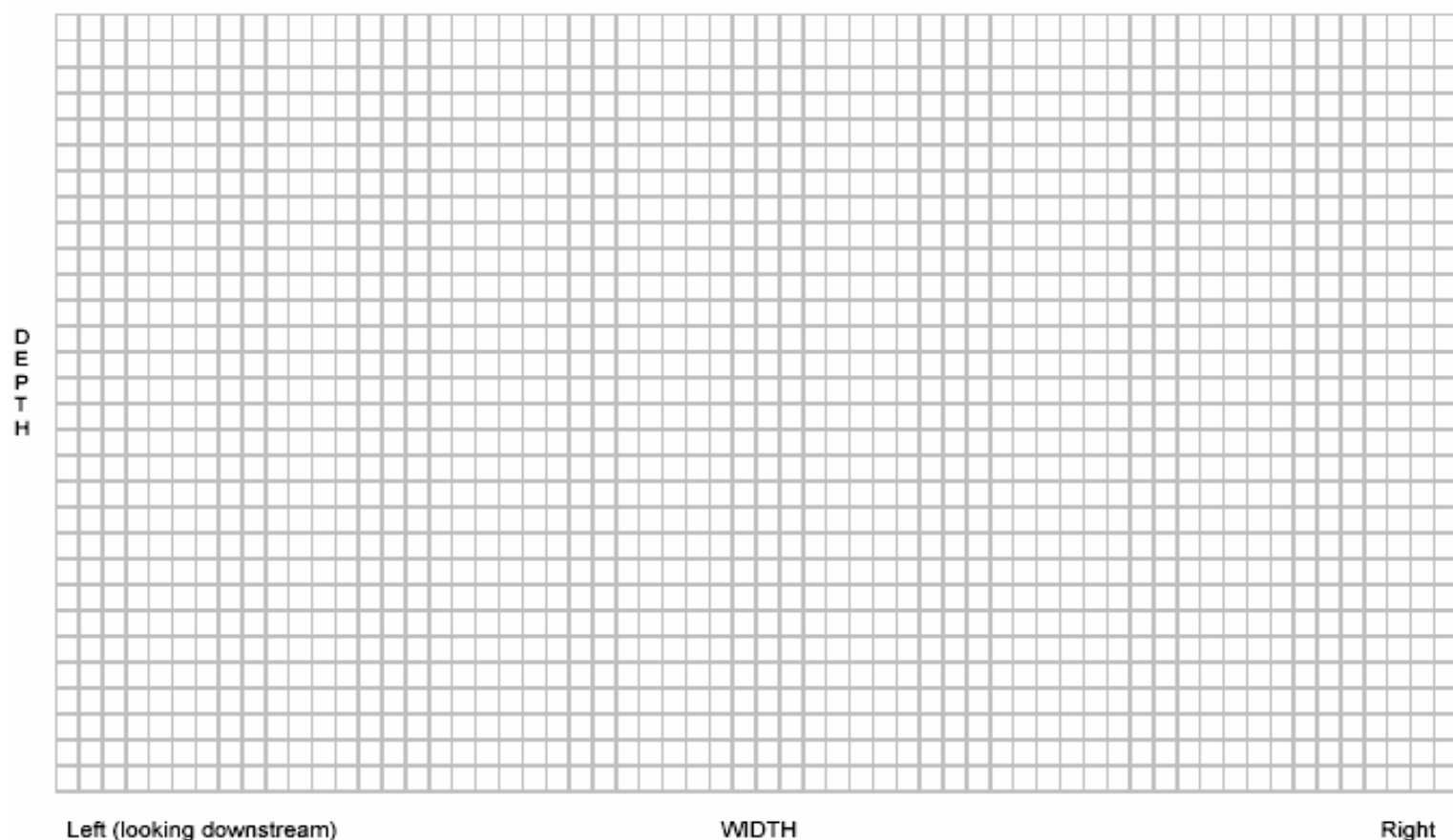
intermittent rain none overcast partly cloudy clear/sunny

Amount of rain, if known? _____ Inches in last _____ hours/days

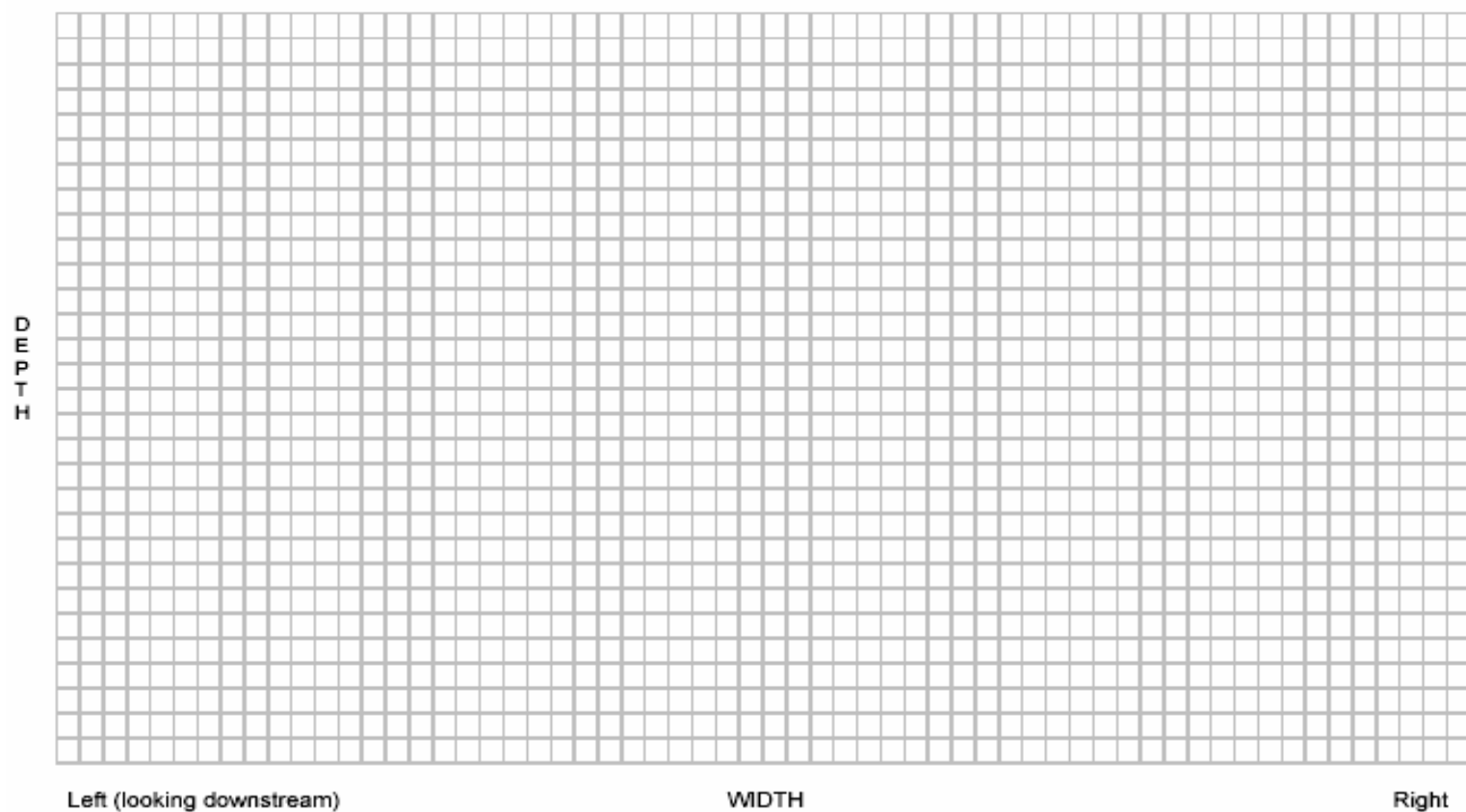
CROSS-SECTION			
Distance from LEFT Pin		Measurement Depth	Comments
Point	Ft.	Ft.	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
21			
22			
23			
24			
25			

CROSS-SECTION			
Distance from LEFT Pin		Measurement Depth	Comments
Point	Ft.	Ft.	
26			
27			
28			
29			
30			
31			
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50			

Graph Paper for Stream Channel Cross-section Measurements



Graph Paper for Stream Channel Cross-section Measurements



Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

- 1 **Stonelfy:** Order Plecoptera. 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)
- 2 **Caddisfly:** Order Trichoptera. Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on lower half.
- 3 **Water Penny:** Order Coleoptera. 1/4", flat saucer-shaped body with a raised bump on one side and 6 tiny legs on the other side. Immature beetle.
- 4 **Riffle Beetle:** Order Coleoptera. 1/4", oval body covered with tiny hairs, 6 legs, antennae. Walks slowly underwater. Does not swim on surface.
- 5 **Mayfly:** Order Ephemeroptera. 1/4" - 1", brown, moving, plate-like or feathery gills on sides of lower body (see arrow), 6 large hooked legs, antennae, 2 or 3 long, hair-like tails. Tails may be webbed together.
- 6 **Gilled Snail:** Class Gastropoda. Shell opening covered by thin plate called operculum. Shell usually opens on right.
- 7 **Dobsonfly (Hellgrammite):** Family Megaloptera. 3/4" - 4", dark-colored, 6 legs, large pinching jaws, eight pairs feelers on lower half of body with paired cotton-like gill tufts along underside, short antennae, 2 tails and 2 pairs of hooks at back end.

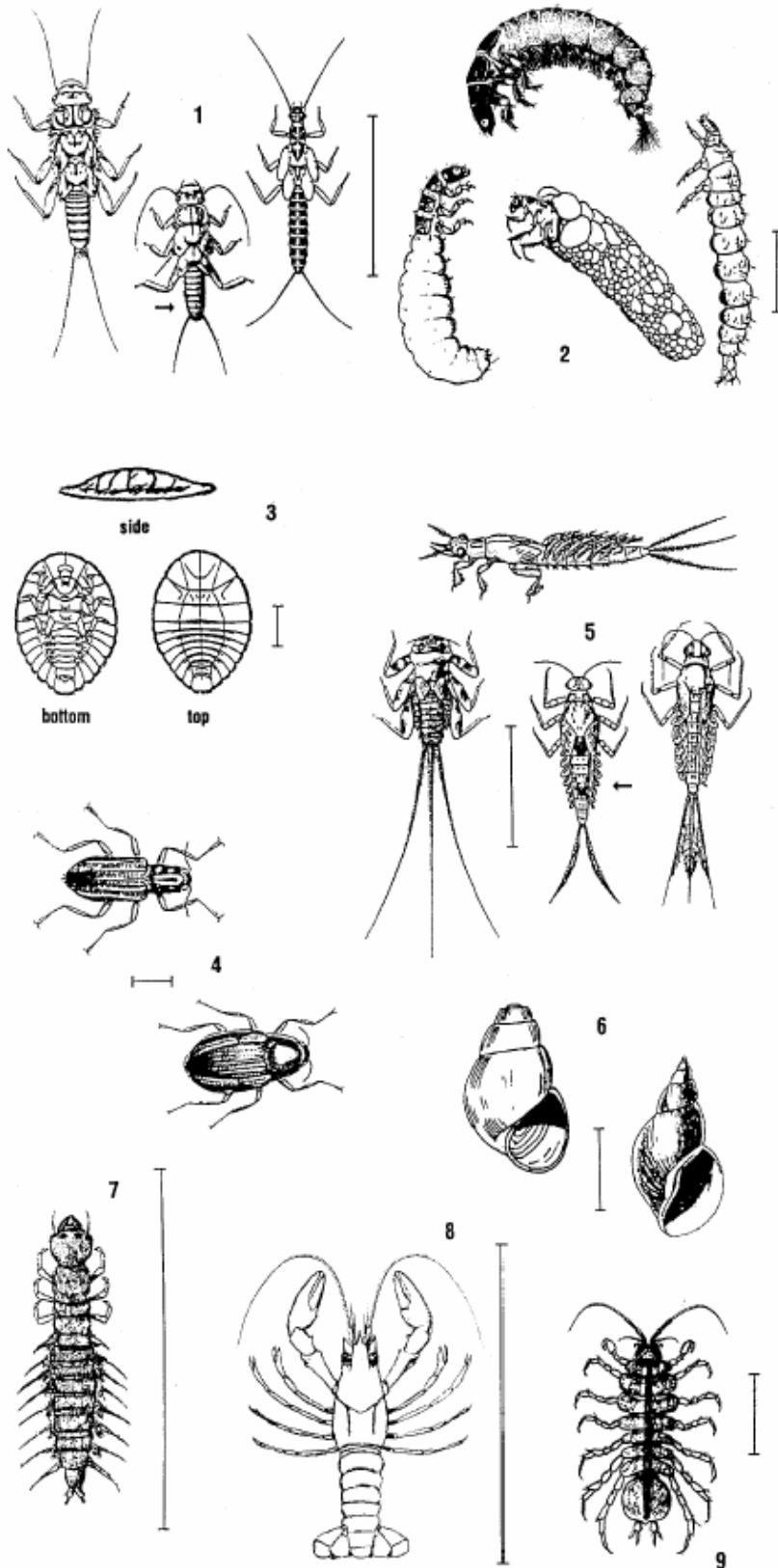
GROUP TWO TAXA

Somewhat pollution tolerant organisms can be in good or fair quality water.

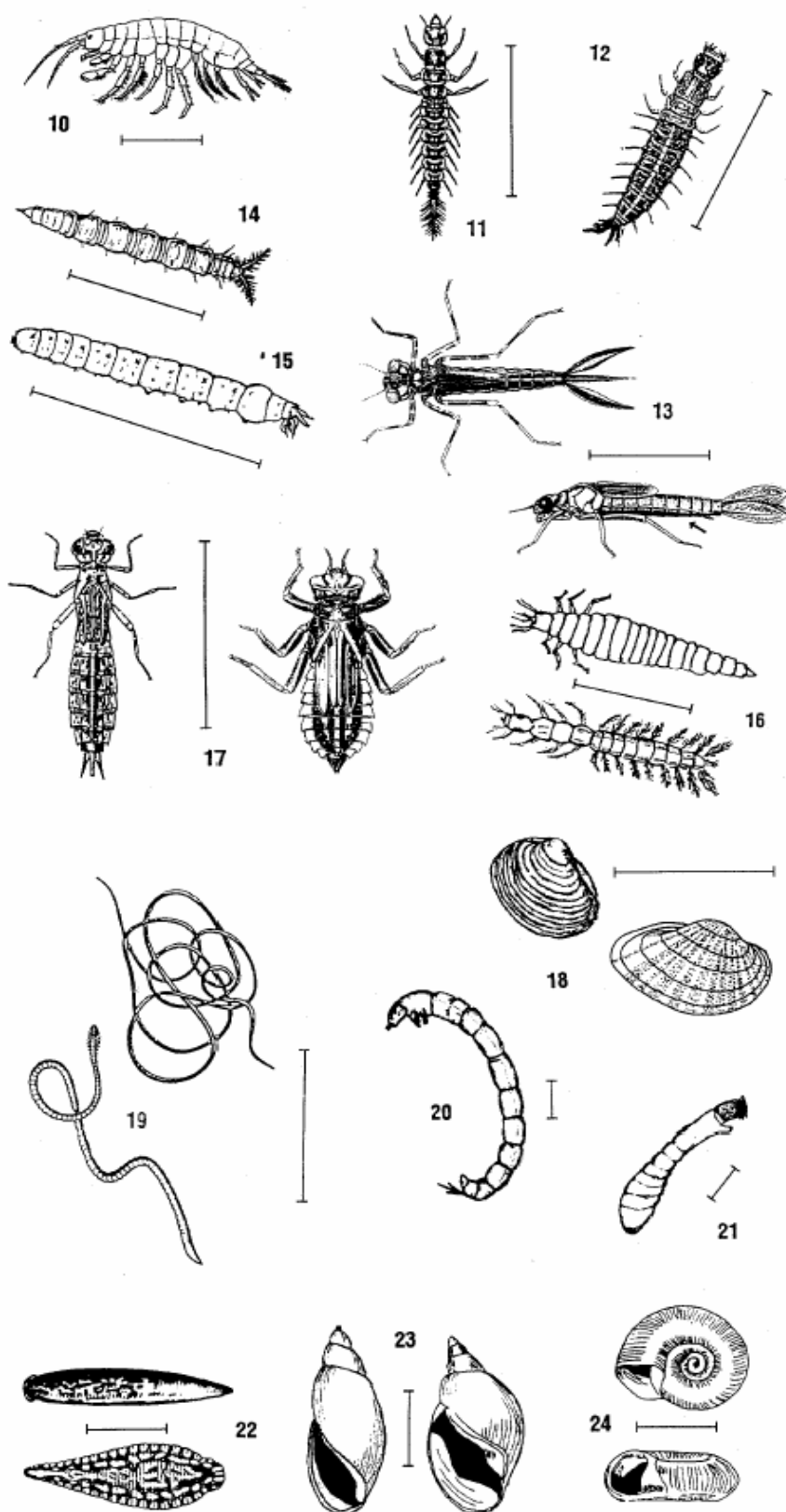
- 8 **Crayfish:** Order Decapoda. Up to 6", 2 large claws, 8 legs, resembles small lobster.
- 9 **Sowbug:** Order Isopoda. 1/4" - 3/4", gray oblong body wider than it is high, more than 6 legs, long antennae.

Save Our Streams

Izaak Walton League of America
1401 Wilson Blvd. Level B
Arlington, VA 22209



Bar lines indicate relative size



Bar lines indicate relative size

GROUP TWO TAXA continued

- 10 Scud:** Order Amphipoda. 1/4", white to grey, body higher than it is wide, swims sideways, more than 6 legs, resembles small shrimp.
- 11 Alderfly larva:** Family Sialidae. 1" long. Looks like small hellgrammite but has 1 long, thin, branched tail at back end (no hooks). No gill tufts underneath.
- 12 Fishfly larva:** Family Corydalidae. Up to 1 1/2" long. Looks like small hellgrammite but often a lighter reddish-tan color, or with yellowish streaks. No gill tufts underneath.
- 13 Damselfly:** Suborder Zygoptera. 1/2" - 1", large eyes, 6 thin hooked legs, 3 broad oar-shaped tails, positioned like a tripod. Smooth (no gills) on sides of lower half of body. (See arrow.)
- 14 Watersnipe Fly Larva:** Family Athericidae (Atherix). 1/4" - 1", pale to green, tapered body, many caterpillar-like legs, conical head, feathery "horns" at back end.
- 15 Crane Fly:** Suborder Nematocera. 1/3" - 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.
- 16 Beetle Larva:** Order Coleoptera. 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae.
- 17 Dragon Fly:** Suborder Anisoptera. 1/2" - 2", large eyes, 6 hooked legs. Wide oval to round abdomen.
- 18 Clam:** Class Bivalvia.

GROUP THREE TAXA

Pollution tolerant organisms can be in any quality of water.

- 19 Aquatic Worm:** Class Oligochaeta. 1/4" - 2", can be very tiny; thin worm-like body.
- 20 Midge Fly Larva:** Suborder Nematocera. Up to 1/4", dark head, worm-like segmented body, 2 tiny legs on each side.
- 21 Blackfly Larva:** Family Simuliidae. Up to 1/4", one end of body wider. Black head, suction pad on end.
- 22 Leech:** Order Hirudinea. 1/4" - 2", brown, slimy body, ends with suction pads.
- 23 Pouch Snail and Pond Snails:** Class Gastropoda. No operculum. Breathe air. Shell usually opens on left.
- 24 Other snails:** Class Gastropoda. No operculum. Breathe air. Snail shell coils in one plane.

Stream Insects & Crustaceans

GROUP ONE TAXA

Pollution sensitive organisms found in good quality water.

- 1 **Stonefly:** Order Plecoptera. 1/2" - 1 1/2", 6 legs with hooked tips, antennae, 2 hair-like tails. Smooth (no gills) on lower half of body. (See arrow.)
- 2 **Caddisfly:** Order Trichoptera. Up to 1", 6 hooked legs on upper third of body, 2 hooks at back end. May be in a stick, rock or leaf case with its head sticking out. May have fluffy gill tufts on lower half.
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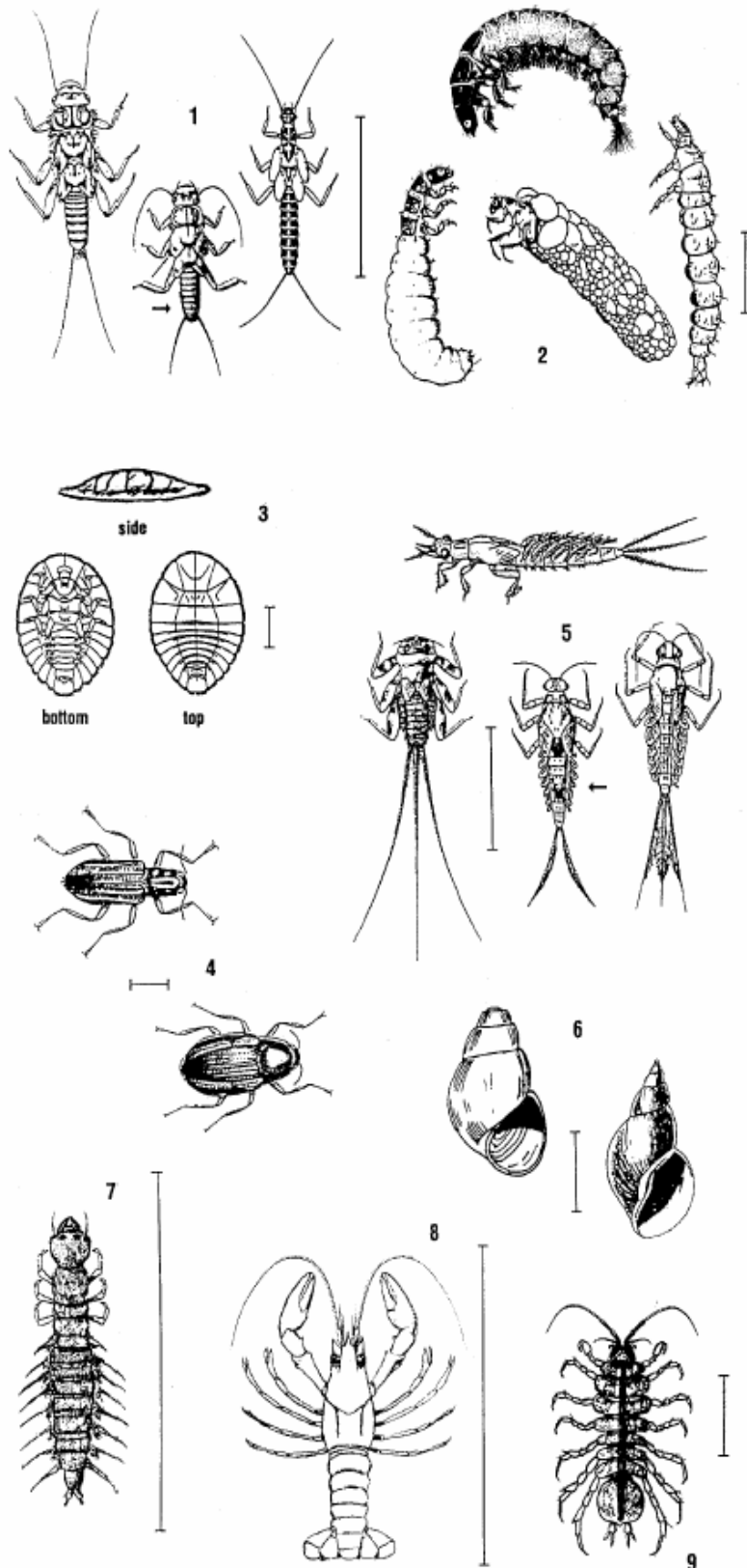
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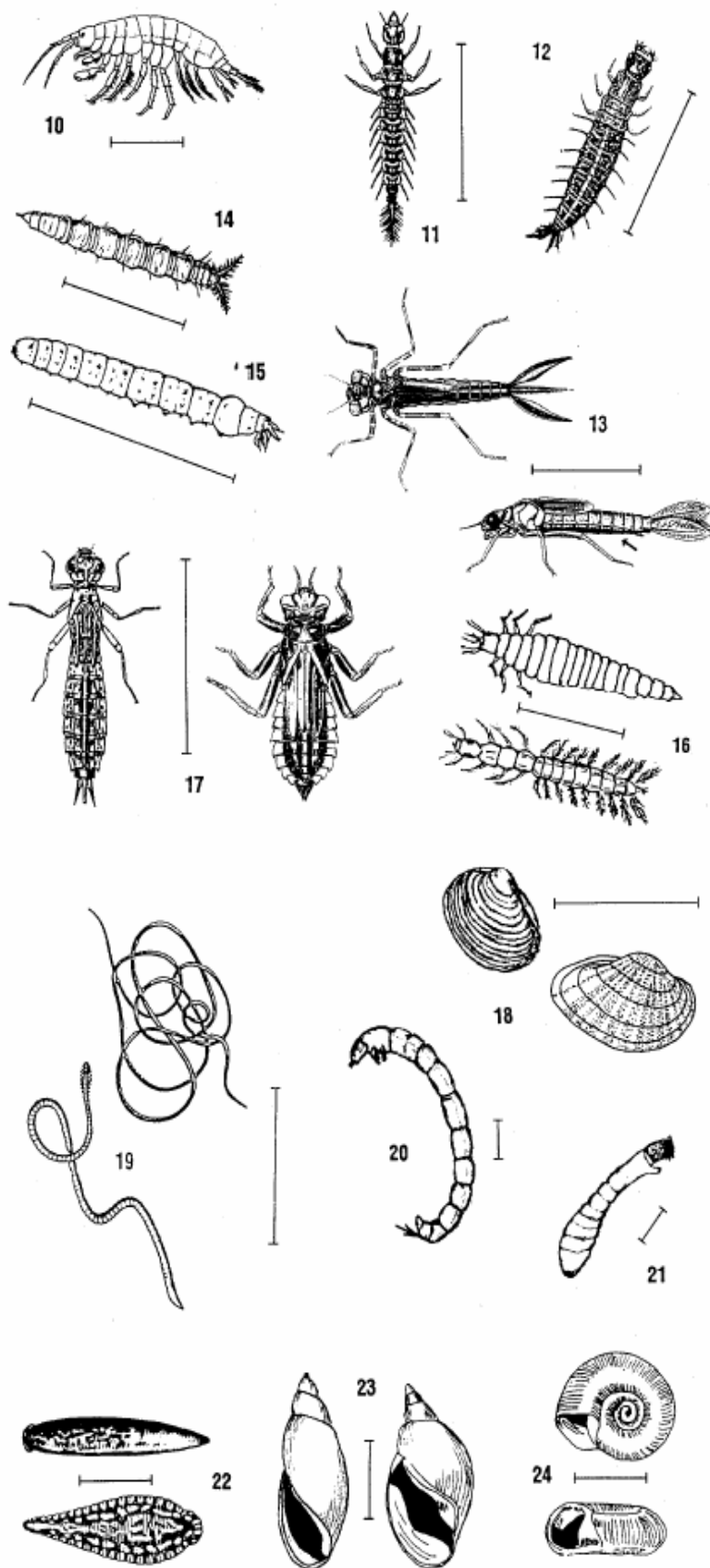
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Bar lines indicate relative size



Bar lines indicate relative size

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- 15 **Crane Fly:** Suborder Nematocera. 1/3" - 2", milky, green, or light brown, plump caterpillar-like segmented body, 4 finger-like lobes at back end.
- 16 **Beetle Larva:** Order Coleoptera. 1/4" - 1", light-colored, 6 legs on upper half of body, feelers, antennae.
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Chemical Data Forms

Group name: _____	County: _____
Site ID _____	Topo Map Quadrant: _____
Investigators: _____	
Stream name: _____	
Date: _____	Time: _____ Photo Documentation? yes / no
Site/location Description: _____	
<p><i>Rain in last 24 hours</i> <i>Present conditions (circle response)</i></p> <p>heavy rain steady rain heavy rain steady rain intermittent rain</p> <p>intermittent rain none overcast partly cloudy clear/sunny</p>	
Amount of rain, if known? _____ Inches in last _____ hours/days	

BASIC TESTS

	Sample 1	Sample 2	
Air Temperature	_____	_____	(°C)
Water Temperature	_____	_____	(°C)
pH	_____	_____	(1-14)
Dissolved Oxygen	_____	_____	(mg/L or ppm)
Settleable Solids	_____	_____	(ml/L)

ADVANCED TESTS

Total Alkalinity	_____	_____	(mg/L or ppm)
Nitrate Nitrogen	_____	_____	(mg/L or ppm)
Ortho-phosphate	_____	_____	(mg/L or ppm)

OTHER TESTS

Fecal Coliform	_____	_____	(cfu /100 mL)
Chlorophyll A	_____	_____	(mg/L or ppm)

Special Lab Analysis: Name of lab performing tests: _____

COMMENTS:

one Year Record

Physical/ Chemical and Biological Data

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Temperature												
Ph												
Dissolved Oxygen												
Settleable Solids												
Nitrate Nitrogen												
O-Phosphate												
Alkalinity												
Turbidity Meter or Secchi Disk												
Other												
Other												
Other												
Biological Index												

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Temperature												
Ph												
Dissolved Oxygen												
Settleable Solids												
Nitrate Nitrogen												
O-Phosphate												
Alkalinity												
Turbidity Meter or Secchi Disk												
Other												
Other												
Other												
Biological Index												

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
Temperature												
Ph												
Dissolved Oxygen												
Settleable Solids												
Nitrate Nitrogen												
O-Phosphate												
Alkalinity												
Turbidity Meter or Secchi Disk												
Other												
Other												
Other												
Biological Index												

Chemical Monitoring Directions

Settleable Solids

1. Fill Imhoff cone to 1 liter mark. Set aside and wait 45 minutes.
2. Take direct reading in ppm (mg/l) from scale on side of cone.

Dissolved Oxygen

1. Carefully collect the water sample into the glass water sampling bottle, avoiding trapping air bubbles or bubbling air into the sample (which may add dissolved oxygen). ***ADD THE REAGENTS HOLDING THE BOTTLES VERTICAL***
2. Add the next two reagents in quick succession. Add 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide to the sample. Cap the sample and invert several times. Wait until the precipitate settles below the neck of the bottle before proceeding.
3. Next, add 8 drops of Sulfuric Acid 1:1. Cap and gently shake until the precipitate dissolves. The solution is now 'fixed' and may range in color from yellow to orange brown. **Fixed Solution** - Contact between the water sample and the atmosphere will not affect the test result because the dissolved oxygen has been bound into solution and no more oxygen will dissolve into the sample and no dissolved oxygen can be lost from the sample.
4. Place 20 mL of the fixed sample into the glass titration tube.

TITRATION STEPS * SWIRL AFTER EACH DROP IS ADDED *

5. Fill the titrator (small syringe) with Sodium Thiosulfate. Make sure no bubbles are in the titrator. Place the titrator into the hole in the cap of the glass titration vial or depending on, which kit is used, hold the eye dropper above the fixed sample.
6. Slowly add Sodium Thiosulfate from the titrator into the sample. Continue one drop at a time until the solution turns a pale straw color. **Hint-High light intensity degrades Sodium Thiosulfate - do not allow bottle to be exposed to the sun for long periods of time.**
7. Remove the titrator cap and syringe CAREFULLY so as not to lose any of the Sodium Thiosulfate (you will continue titrating in step 9).
8. Add 8 drops of Starch Solution to the titration vial that is holding the sample. The sample will turn dark blue.
9. Continue titrating with Sodium Thiosulfate **ONE DROP AT A TIME** until the solution turns from blue to clear.
10. Read the amount of dissolved oxygen in your sample directly from the syringe (direct reading titrator). Tick marks are in 0.2 ppm. Use the tip of the syringe plunger for dissolved oxygen value.

Temperature

1. Air temperature - place thermometer in shady area and record temperature after reading stabilizes. Record temperature as °C.
2. Water temperature - take the temperature reading of the water in the shade. It is best to take the temperature reading directly in the stream, but if you can not, place thermometer directly into a bucket of sample water (in the shade) and record temperature. Take reading after temperature has stabilized (about 2 minutes). Record temperature as °C.

pH

1. Fill test tube to the 5 mL line of the glass tube.
2. Add 10 drops of the pH wide range indicator (holding indicator bottle vertical). Cap and gently invert the sample several times to ensure mixing.
3. Use the color comparator box to determine pH.

Alkalinity

1. Fill titration tube to 5 mL line with water sample.
2. Add one Phenolphthalein indicator tablet/pillow into the sample. If the sample doesn't turn red, the phenolphthalein alkalinity is zero (Skip to step 4). If sample turns red, proceed to step 3.

3. If the water becomes pink, add Sulfuric Acid Standard Solution (or the Alkalinity Titration Reagent B) drop wise, counting drops, until the water becomes colorless. Test result is read where plunger tip is located at the Titrator scale (on the syringe) in ppm.
4. Add one Bromcresol Green-Methyl Red (BCG-MR) tablet to the sample and swirl to mix.
5. Using syringe, begin titrating Sulfuric Acid Standard Solution (or Alkalinity Titration Reagent B) drop wise, counting drops and swirling the sample, until the solution flashes pink and holds purple color for at least 30 seconds (the end point). If no color change occurs after the titrator is emptied, refill and continue the titration, keeping track of the amount added.
6. Once this endpoint is reached, the alkalinity is calculated. The test result is read in ppm where plunger tip is located at the titrator scale (on the syringe).

Phosphate

1. Fill 3 test tubes (one sample and two blanks) to the 10 mL mark with sample water. Place in axial reader.
2. Using 1.0 mL pipet add 1.0 mL of Phosphate Acid Reagent to sample test tube. Cap and mix.
3. Use 0.1 g spoon to add one level measure of Phosphate Reducing Reagent to sample test tube. Cap and mix until dissolved.
4. Wait 5 minutes.
5. Remove cap from test tube. Place test tube in comparator with axial reader. For accurate readings, fill 2 extra test tubes with sample water and place to the left and right of test tube sample. Insert ampole in Octet Comparator in square hole in front of test tube sample. Slide axial reader up or down to match sample color to a color standard. (Check diagram to the right.)

Nitrate Nitrogen

1. Fill test tube to 5 mL mark with water sample.
2. Add one nitrate #1 tablet. Cap and mix until tablet disintegrates.
3. Add one nitrate #2 CTA tablet. Cap and mix until tablet disintegrates.
4. Wait 5 minutes.
5. Insert nitrate nitrogen Octa-slide bar into Octa-Slide viewer. Insert test tube into Octa-Slide viewer. Match sample color to color standard. Record as parts ppm Nitrate Nitrogen. (To convert to Nitrate, multiply results by 4.4. Record as ppm nitrate.)

Salinity

To conduct the salinity titration, only a small amount of sample water is actually needed.

1. Fill the titration vial to the line with Demineralized water from the Demineralizer bottle. Be as precise as you can.
2. Using the pipette that ranges from 0 to 1.0, fill the pipette with sample water to the zero mark (volume = 1.0 mL). Wipe off any excess sample water from the pipette tip. Insert pipette into titration vial.
3. Add only 0.5mL of the sample water from the pipette (from the zero mark to the 0.5 mark). Remove pipette from vial and lay pipette aside.
4. Remove top from titration vial, and add 3 drops of the yellow-colored chromate indicator reagent; replace titration vial cap, and mix well.
5. Fill the other pipette (that ranges from 0-20) with Silver Nitrate titration reagent. (NOTE: Silver nitrate is clear, but when it dries, it leaves a dark brown or black stain. You might notice such spots on your hands and fingers and possibly clothes if not wearing gloves).
6. Place pipette in top of titration vial. Add silver nitrate solution one drop at a time, with plenty of swirl mixing after each drop. The end-point will be when the yellow solution turns orange and stays orange.
7. When the end point is reached, read the pipette to determine the volume of silver nitrate added. NOTE that the pipette "numbers" are in twos, and thus each small hash mark between numbers represent 0.4. The volume of silver nitrate added equals the numerical value of the salinity (in ppt).

Secchi Disk

The Secchi disk is a disk 20 centimeters in diameter with black and white quadrants (or solid white).

1. Attached to a calibrated line, the disk is lowered into the water until it just disappears from sight.
2. The depth (distance from disk to the surface of the water) is noted and the disk is slowly raised until it reappears.
3. The depth is noted again and the average of the two readings is recorded as "Secchi Depth," usually measured in meters. If the Secchi disk reaches the bottom before disappearing, the Secchi Depth is greater than the water depth and cannot be accurately measured. When this occurs, a notation must be added to the Secchi Depth reading in your data.

How To Make A Kick Seine

For collecting macroinvertebrates (courtesy of the Tennessee Valley Authority)

Materials:

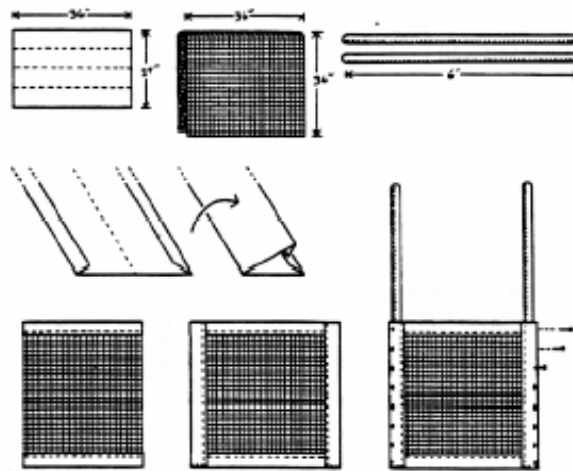
- 3 foot by 3-foot piece of nylon or metal window screening
- 4 strips of heavy canvas (6 inches by 36 inches)
- 2 broom handles or wooden dowels (5 or 6 feet long)
- finishing nails
- thread
- sewing machine
- hammer
- iron and ironing board

Procedure:

1. Fold edges of canvas strips under, 1/2 inch, and press with iron.
2. Sew 2 strips at top and bottom and then use other 2 strips to make casings for broom handles or dowels on left and right sides. Sew bottom of casings shut.
3. Insert broom handles or dowels into casings and nail into place with finishing nails.

Speed method:

1. Lay 3 foot by 3-foot piece of screening over broom handles.
2. Staple or nail screen to broom handles.



Wetland Identification and Monitoring

Major Categories	General Location	Wetland Types
<i>Coastal Wetlands</i>		
Marine (undiluted salt water)	Open Coast	Shrub wetland, salt marsh, mangrove swamp
Estuarine (salt/freshwater mix)	Estuaries (deltas, lagoons)	Brackish marsh, shrub wetland, salt marsh, mangrove swamp
<i>Inland Wetlands</i>		
Riverine (associated with rivers & streams)	River channels & flood plains	Bottomlands, freshwater marsh, delta marsh
Lacustrine (associated with lakes)	Lakes & deltas	Freshwater marsh, shrub and forest wetlands
Palustrine (shallow ponds & freshwater wetlands)	Ponds, peatlands, uplands, groundwater seeps	Ephemeral ponds, tundra peatland, groundwater spring oasis, bogs

Classification system developed by Cowardin (1979) and used by U.S. Fish and Wildlife Service

Wetland Functions and Values

Now that you have determined the broad classification of your adopted wetland, ask yourself, “Just how important is this ecosystem?” Wetlands of any size have values and functions, which are beneficial to human society or are of intrinsic importance. Wetland **functions** are those processes that occur in a wetland system irrespective of human activity. Depending on the wetland type, functions include floodwater storage, erosion control, water purification, sediment trapping, chemical and organic waste processing, nutrient removal, groundwater discharge and recharge, and animal and plant habitat. These characteristics will continue to occur regardless of man’s presence. Wetland **values** are those ecosystem processes that are perceived to have a positive impact on people. Values may change over time as the perception of human society changes over time.

Wetland values and resources for humans may include food, fuel, timber and fiber harvest, recreation, aesthetics, and education. Of course, wetland functions can and should be “valued” by society, but that is not always the case.

Check off the Functions and Values of your wetland on the following chart. You may have to do a little research into local history and uses of your wetland to complete the chart. Consider how the community generally regards your wetland area. Remember, not all functions are necessarily values and vice versa!

Rank the characteristics from 1 - 5 (with 5 being the most important) to get an idea of which functions and values are considered more important. Photocopy the following chart and try to rank the functions and values of your wetland once a year.

<i>Wetland Characteristic</i>	<i>Wetland Function?</i>	<i>Value To Your Community?</i>
<p>Recreational Values</p> <ul style="list-style-type: none"> _ hunting permitted? _ fishing for food or sport? _ nature trails or wildlife observation points? <p>Fish, Wildlife and Plant Habitat</p> <ul style="list-style-type: none"> _ wetland in migratory bird pathway? _ nesting of birds in wetland? _ habitat for mammal, birds, fish, amphibians and reptiles? <p>Intrinsic</p> <ul style="list-style-type: none"> _ only “natural” or green area in community? _ site for scientific research? _ habitat for endangered or threatened species? <p>Economic</p> <ul style="list-style-type: none"> _ timber, fish, shellfish production? _ tourist attraction? _ timber or vegetation harvested? <p>Educational</p> <ul style="list-style-type: none"> _ nature preserve or county park? _ nature center or interpretive trail? _ historical artifacts in or around wetland? <p>Flood Storage</p> <ul style="list-style-type: none"> _ located in headwaters of the watershed? _ downstream in watershed? _ is it a riverine wetland? _ large enough to store and diminish flood waters? <p>Groundwater Recharge and Discharge</p> <ul style="list-style-type: none"> _ recharge for community’s drinking water supply? _ does the community rely heavily on groundwater for water supply? <p>Erosion Control: Channel and Shoreline</p> <ul style="list-style-type: none"> _ does a prominent river or stream run through the community? _ wetland associated with river, coast or lake? <p>Water Purification: Surface and Groundwater</p> <ul style="list-style-type: none"> _ filter runoff water and release clean water? _ trap polluted runoff or excess nutrients? 		

Visual Survey Form

Use this form to record important information about vegetation, soils, and hydrology in your wetland.

Wetland Name: _____

Group Name: _____

Site Number: _____

Members Present: _____

Date: _____

County: _____

Weather Conditions: (circle one)

Clear

Cloudy

Rain

Rain within last 24 to 48 hours?

Visual Survey

Water _____ Precipitation _____ Groundwater _____ Stream/river _____ Coastal _____ Other _____
Source: _____ /lake _____

Name of associated river/stream/lake: _____

Name General Wetland

Circle type of system

Open System

Close System

Classification: _____

Surface Water

Odor:

Appearance:

___ clear ___ milky / gray
___ muddy ___ green
___ oily ___ brown
___ foamy ___ black
___ scum ___ other: _____

___ none ___ rotten eggs
___ natural ___ sewage
___ gasoline or oil ___ chemical
___ chlorine ___ other: _____

Wetland Buffer:

Excellent

Good

Fair

Poor

(within 25 ft. from wetland)

Natural Vegetative

Cover

Bank Stable- no erosion

Undisturbed land

Impacts To Wetland:

___ Artificial water control (dam, dyke, etc)

___ Eroded banks

___ Dredging

___ Algal blooms

(Indicates nutrients)

___ Dumping of sand, dirt, gravel

___ Trash

___ Clearing of vegetation

___ Other:

Transect **Locations**

Location of transect upland point _____

Length of transect _____ ft.

Compass bearing along transect _____ (degrees)

Numbers of stations along transect _____

Location of transect wetland point _____

Vegetation Survey

At each sampling station, look at the area within a 5 foot radius from the point along your transect. Identify the 3 dominant species in each layer. Record species name (cypress, red maple, lizard tail, cattail, etc.) and wetland indicator status (obligate, FacWet, Fac, Upland) if known.

Layers	Station 1	Station 2	Station 3
Tree			
Shrub			
Herbaceous Layer			

Vegetation **Survey**

Layers	Station 4	Station 5	Station 6
Tree			
Shrub			
Herbaceous Layer			

How many plant communities (obvious changes in vegetation) do you see along your transect?

soil **Survey Form**

To collect your soil sample, use a spade or small shovel to dig an 18-inch-deep hole at each transect station. Using the soil color chart, determine the representative color of the soil at each transect (including upland areas). Fill in your observations in the following table:

	Station 1	Station 2	Station 3
Color (from Color Chart)			
Smell			
Degree of wetness (wet, damp, dry)			
Texture (clay, sandy, sticky)			

Soil Survey Form

	Station 1	Station 2	Station 3
Color (from Color Chart)			
Smell			
Degree of wetness (wet, damp, dry)			
Texture (clay, sandy, sticky)			

Observations of wetland soil:

Are there any defined layers to the wetland soil? If so, describe.

Is there mottling (concentrated areas of red or yellow soil)?

How deep do the plant roots go? _____(Inches)

Is there standing water in the hole? _____How many inches to the surface?
 _____(Inches)

What organisms are living in the soil?

From *A World in Our Backyard*, with permission through the GA, Adopt a Stream Program

Hydrology Survey Form

Name of Wetland: _____

Date: _____

Answer the following questions. Depending on the time of year, precipitation amounts, and various other factors, a wetland may appear dry.

	Station 1	Station 2	Station 3
Depth of surface Water			
If no surface water, is water filling the hole?			
Surface Water Movement (slow, fast, none)			
If no water, name hydrology indicators (water marks, drift lines, sediment deposits, water stained leaves, drainage patterns)			
	Station 4	Station 5	Station 6
Depth of surface Water			
If no surface water, is water filling the hole?			
Surface Water Movement (slow,fast, none)			
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Information for this package was compile from:

Georgia Adopt-A-Stream program, (www.riversalive.org/as.html)

The National Science Foundation's Wetlands Teachers Guide, (www.nsf.gov),

Activities Integrating Mathematics and Science *Water precious Water*, P.O. Box 8120 Fresno, CA 93747- 8120

Air and waste Management, *Environmental Resources Guide*, One Gateway Center, Third Floor Pittsburgh, PA 15222

Always A River, EPA, Form# AWBERC-91-09

Aquatic Project, **WILD**, 5430 Grosvenor Lane Bethesda, MD 20814

Georgia Wildlife Resource Division, 2425 Marben Farm Rd. Mansfield, GA 30255

Save Our Streams, 707 Conservation Lane, Gaithersburg, MD 20878-2983

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The Georgia Adopt-A-Stream Program
U.S. Fish and Wild Life Service

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For additional information about supplemental projects and procedures, or to ask question about the production of this package, please contact NOAA Fisheries, 17 Godfrey Drive – Suite 1, Orono, ME 04473. (207.866.7422)

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